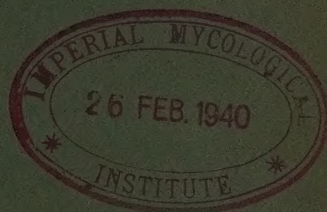
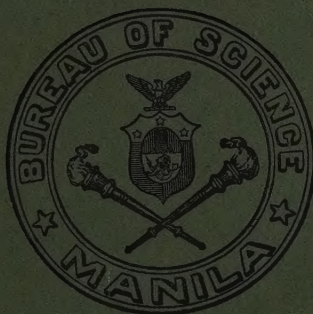


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THE PHILIPPINE BLENNIES

By ALBERT W. C. T. HERRE
Of Stanford University, California

FIVE PLATES

Although blennies are common on all Philippine coasts, they are but little or not at all known by most Filipinos. They are abundant in tide pools and on rocky shores throughout, but as they are all small, and do not occur in schools, they are not taken by commercial fishermen. They are therefore seldom seen in the markets, and are not caught by people fishing for their own use. Some Philippine species remain in deeper water, living on the bottom around reefs in coastal waters, and one is pelagic. Certain very small species live commonly in the interstices of coral heads.

The blennies of the world form a very large and natural group that is particularly well developed in the colder regions of the earth. There they attain a much larger size than in the Tropics. Some of those in cold temperate and arctic waters are big enough to be of considerable importance as food fishes. Blennies are mainly shore and shallow-water forms, but also include pelagic and deep-water species. The ventral fins consist of 1 spine and 1 to 3 rays; they are always jugular when present, but may be reduced to mere threads, or may even be absent. The body is usually elongate, cylindrical, and naked, but scales may be present. The teeth may be fixed in the jaws, or may be movable and merely set in the gums; canines are often present in the lower jaw, and some genera have them in both the upper and lower jaws. No molars occur in any Philippine genera. There

may be one, two, or three dorsal fins, occupying most or all of the back from the nape to the caudal base; the dorsal may be composed entirely of spines, or of spines and rays, or spines may be lacking. The caudal is nearly always present, and may be distinct from the dorsal and anal, or may be confluent with them. The anal fin may have a moderate or large number of rays.

There are 50 species of blennies in Philippine waters and in the adjacent Sea of Celebes. They are distributed among 4 families and 13 genera. With one exception they are all rather small, and with two exceptions are all shore or reef dwellers. Our longest blenny is a pelagic species. All are found in salt water except one small species found only in Lake Bombon. Most blennies are carnivorous, but the commonest Philippine blennies are vegetarian, feeding on algæ. As a rule blennies lay eggs, although some species are viviparous.

The common blennies of Philippine seacoasts are among the most active and agile of all fishes. Their acrobatic feats on exposed rocks at low tide rival or even surpass those of *Periophthalmus*, the famed talimosak or mud skipper, and are equally surprising. Their popular names of rock skipper or rock springer are therefore exceedingly apt.

We may divide the Philippine blennies among 4 families, the Clinidæ, the Blenniidæ proper, the Xiphasiidæ, and the Congrogadidæ.

Key to the families of Philippine blennies.

- a*¹. Body covered with scales; spinous dorsal with hard sharp spines, much longer than soft dorsal..... CLINIDÆ.
- a*². No hard sharp spines.
 - b*¹. Spinous and soft-rayed parts of dorsal subequal, caudal free or more or less united with dorsal; dorsal, anal, and caudal confluent in one genus. Body naked, not eellike..... BLENNIIDÆ.
 - b*². Dorsal very long, entirely composed of soft rays, or with only a few soft spines anteriorly; caudal, dorsal, and anal confluent.
 - c*¹. Body naked, eellike, dorsal origin over or before eye, all fin rays flexible; tail four to six times as long as head and trunk together. XIPHASIIDÆ.
 - c*². No ventrals; body covered with very small scales; lips strongly developed; dorsal origin behind head; no dorsal spines; tail less than twice as long as head and trunk together.... CONGROGADIDÆ.

CLINIDÆ

Small tropical blennies, body nearly always covered with scales. Spinous portion of dorsal fin longer than rayed, soft portion, or all rays converted into spines; in some species dorsal

with two spinous parts and a shorter-rayed portion; anal with one or two spines; ventrals on throat, composed of a spine and three or four simple articulated rays. Gill membranes united, free from isthmus. Jaws with conical or villiform teeth, often teeth on vomer and palatines.

The group is positively represented in Philippine waters by two genera, and a third genus is doubtfully recorded. The species occur on coral reefs, especially in and around coral heads.

Key to the Philippine genera of Clinidæ.

- a*¹. Three dorsal fins, the two anterior ones composed of soft spines; anal spines also soft..... *Tripterygion*.
*a*². Two dorsal fins.
 *b*¹. First dorsal composed of 3 spines; second dorsal composed of 25 to 30 spines and 3 to 8 rays, all spines hard and sharp; anal with 2 hard sharp spines and 19 to 25 rays..... *Cristiceps*.
 *b*². First dorsal composed of 2 long threadlike spines; second dorsal, 45 to 50; anal with more than 50 rays..... *Paracristiceps*.

Genus *TRIPTERYGION* Risso

Tripterygion RISSO, Hist. 3 (1826) 241.

Enneapterygius RÜPPELL, Neue Wirbelt. Fische (1835) 2.

Tripterygium GÜNTHER, Cat. Fishes 3 (1861) 276.

Body not elongate, covered with small or medium-sized scales. Dorsal fins 3, first dorsal fin composed of 3, second of 10 to 24 soft spines, third of 7 to 14 rays; anal with 1 or 2 soft spines and 14 to 22 rays. Ventrals jugular, composed of 2 soft rays. Branchiostegals 6; pseudobranchiæ present.

Small fishes of tropical reefs and tide pools, commonly living in the interstices of coral heads, and therefore difficult to observe or collect. Also abundant about New Zealand, in the Mediterranean, and in other warm temperate waters. Four species are recorded from Philippine waters.

Key to the Philippine species of Tripterygion.

- a*¹. Scales 47 to 50; dorsals III, XIII, 9 or 10; anal I, 18 to 20.
 1. *T. trigloides*.
*a*². Scales 30 to 33; dorsals III, X or XI, 7 to 9; anal I, 14 to 16.
 *b*¹. Pectoral with 7 or 8 undivided and 8 divided rays; dorsals III, X or XI, 9; anal I, 14 or 15..... 2. *T. callionymi*.
 *b*². Pectoral with 6 undivided lower rays.
 *c*¹. Dorsals III, XI, 9; anal I, 15 or 16; divided pectoral rays 9; caudal faintly barred, anal clear with black spots..... 3. *T. philippinum*.
 *c*². Dorsals III, X or XI, 7 or 8; anal I, 14 or 15; divided pectoral rays 7 or 8; caudal and anal black..... 4. *T. punctulatum*.

1. *TRIPTERYGION TRIGLOIDES* Bleeker.

Tripterygion trigloides BLEEKER, Nat. Tijds. Ned. Ind. 15 (1858) 234.

Tripterygion trigloides M. WEBER, Fische Siboga Exped. (1913) 545, fig. 115; HERRE, Fishes 1931 Philip. Exped. (1934) 95.

Dorsals III, XIII or XIV, 9 or 10; anal I, 18 to 20. Head and nape naked, with 47 to 50 scales in a longitudinal series, plus 1 or 2 on caudal base, scales more or less irregular; tubulated scales in lateral line 18 to 22, stopping beneath hind end of the second dorsal or front of third dorsal.

Depth 5, head 3.2 to 3.4, caudal 5, pectoral 3.8 to 3.9 times in length. Head very large, broad, shaped like that of *Trigla*, anterior profile convexly rounded with protruding lips and large mouth extending beneath middle of eye. Snout 2.75 to 2.85, eye 3.3 to 3.66 times in head. Upper 10 rays of pectoral divided, lower 6 undivided.

Alcoholic specimens reddish brown to pale tan, with irregular spots and flecks of silvery white scattered over sides; over back and down sides 5 double crossbars, varying from dark red-brown to blackish; top and sides of head thickly sprinkled with black dots, upper lip dark purple to blackish; dorsals and caudal barred with dusky bands, or dorsals largely covered with dark red-brown specks; anal varying from clear, with a few red-brown spots or bands, to entirely dusky, difference probably being sexual. Iris golden red.

I collected 5 examples, 22 to 28 mm long, at Dumaguete, Oriental Negros Province, and 2 very fine specimens, 34 and 35 mm long, at Lembeh Strait, Celebes. Weber had 1 specimen, 35 mm long, from Tiur, a small East Indian island, and Bleeker had 1 specimen, 38 mm long, from Billiton. In life this blenny is very handsome, largely rose-red, with iridescent spots and flecks of pearly blue.

2. *TRIPTERYGION CALLIONYMI* M. Weber.

Tripterygion callionymi M. WEBER, Notes Leiden Museum 31 (1909)

147; Fische Siboga Exped. (1913) 546, figs. 116 and 117; HERRE, Fishes 1931 Philip. Exped. (1934) 95.

Dorsals III, X or XI, 9; anal I, 14 or 15; pectoral with 8 divided and 7 or 8 undivided rays. Scales 31 to 33, plus 1 or 2 on caudal base; 3 scales above, and 6 below lateral line. Weber's specimens had 12 spines in the second division of the dorsal.

Depth 5, head 4.5 times in length. The peculiar concave, sharp-pointed snout equals the large prominent eye, $3\frac{1}{2}$ times in head. Scales extending forward to nape; lateral line extend-

ing back on 12 to 14 scales to a point under middle of second dorsal; dropping down two scale rows, it is represented from there to the caudal base by a semicircular pit on the hind margin of 17 to 19 scales. Second dorsal highest, caudal truncate.

Yellowish, thickly sprinkled with large and small black dots, between silvery spots and lines. Other specimens with 6 double crossbars, vaguely defined on back, upper half, and on caudal base, and a row of spots at anal base; very poorly defined crossbands on dorsal, a row of dots on anal. Some specimens have the markings much like those of *Enneapterygius fasciatus* (M. Weber) but with the entirely different snout and physiognomy of *E. callionymi*.

I collected Philippine examples as follows, from 16 to 26 mm long: Culion 2; Dumaguete 5; Sitankai 1. Weber obtained 9 specimens at various stations from Celebes to Lombok.

3. TRIPTERYGION PHILIPPINUM Peters.

Tripterygium philippinum PETERS, Monatsber. Akad. Wiss. Berlin (1868) 269.

Enneapterygius philippinus JORDAN and RICHARDSON, Bull. Bur. Fish. 27 (1908) 283.

Dorsals III, XI, 9; anal I, 15 or 16; scales 30 to 32 in a lateral series, plus 1 or 2 on caudal base; 12 tubulated scales in lateral line, 18 with pores in hind margin along middle of side back to caudal base.

Depth 5 to 5.75, head 3.7 to 3.8, caudal 5.75, pectoral 2.75 to 3.25 times in length; eye 3 to 3.2, snout about 3.4, least depth of caudal peduncle 3 times in head. Lower 6 pectoral rays undivided, upper 9 divided. Nasal tentacles very short; no orbital tentacles. Small snout, pointed as in other members of the genus.

Rose-red in life, becoming clear brown or fading to pale yellow in alcohol, head more or less thickly sprinkled with dark or blackish specks. Below pectoral base a large silver spot, a pair of smaller silver spots before ventral base; dorsal more or less spotted with dusky, pectoral with 4 rows of black specks. At caudal base a silvery or red blotch; caudal fin faintly barred with dark spots.

Peters's description was made from 2 specimens, each 25 mm long, from a coral reef near Paracale, Camarines Norte Province. Jordan and Richardson described 2 examples, 18 and 23 mm long, collected by R. C. McGregor at Calayan Island, one of the Babuyan, north of Luzon. These are in the Stanford University Museum, and have been examined by me.

4. TRIPTERYGION PUNCTULATUM (Herre).

Enneapterygius punctulatus HERRE, Fishes Crane Pacific Exped. F. Mus. Nat. Hist. Zoölogy 21 (1936) 397, fig. 37.

Three specimens of this rare little fish were taken from a tide pool at Nasugbu, Batangas Province, 16 to 21 mm long.

Dorsals III, X or XI, 7 or 8; anal I, 14 or 15; scales 32, plus 2 on caudal base; 13 to 15 tubulated scales in upper part of lateral line, 3 above and 6 below it; along middle of side 16 to 18 scales with pores on hind margin. All dorsal and anal rays simple, except last one of each.

Depth 5.25, head 3.7, pectoral 3.5 to 3.6, caudal 4.2 times in length. Eye 2.85, snout 2.9 to 3, depth of caudal peduncle 3.5, height of second dorsal 1.9 times in head. Head broad, resembling that of a *Trigla*, with large prominent eyes set very close together, and small, pointed snout. Orbital tentacle minute. First dorsal very low; large pectoral extending nearly to hind end of second dorsal; caudal rounded. Uppermost 7 or 8 pectoral rays divided, lower 6 undivided.

Alcoholic specimens whitish, heavily shaded with black dots that may form vague crossbands. Dots largest and most numerous on lower half and breast and under head, those on underside often ocellated. Caudal and anal blackish or black; second dorsal with a dusky margin, a black bar sometimes present at base of second and third dorsals.

Previously known only from specimens I obtained in the New Hebrides.

Genus CRISTICEPS Cuvier and Valenciennes

Cristiceps CUVIER and VALENCIENNES, Hist. Nat. Poiss. 11 (1836) 194-402.

Body of moderate length, covered with small or rudimentary scales. Snout short, mouth of medium size, lower jaw often prominent. Jaw teeth small, in bands; vomerine and palatine teeth present. Dorsals 2, first dorsal on head, composed of 3 sharp spines; second dorsal long, composed of 25 to 30 sharp spines and 3 to 8 rays; anal with 2 hard sharp spines and 19 to 25 rays; dorsal rays may be united with caudal; ventrals jugular, composed of 1 spine and 2 or 3 rays. Tentacles present on eye and nostril. Gill opening wide; branchiostegals 6. The species are viviparous.

But 1 species is known from the Philippines. Small fishes, species few, occurring on reefs in the East Indies, in rivers and

along the shores of Australia and Tasmania, and in the Mediterranean.

CRISTICEPS XANTHOSOMA (Bleeker).

Clinus xanthosoma BLEEKER, Nat. Tijds. Ned. Ind. 13 (1857) 340.

Cristiceps xanthosoma GÜNTHER, Cat. Fishes 3 (1861) 273; HERRE, Philip. Journ. Sci. 59 (1936) 371.

First dorsal III, second dorsal XXVII, 4; anal II, 19; about 50 tubules in lateral line; scales very small, not deciduous, about 110 above and 100 below lateral line.

Depth 4, head 3.48, caudal and pectoral each 5.55, ventral 6.1 times in length; eye 4.16, snout 5, maxillary 2.7, interorbital 7 times in head.

Body deep, laterally compressed, ventral profile strongly convex; head moderately arched from dorsal origin to tip of projecting lower jaw; eyes high up, lateral, with a fimbriate tentacle on margin of each, half or more than half eye in length; a small simple nasal tentacle; mouth strongly oblique, maxillary extending beneath front margin of pupil; small teeth forming a band of 5 rows in front, dwindling to a single row posteriorly, alike in both jaws; minute teeth on vomer and palatines. Dorsal spines all hard and sharp-pointed, with only 4 divided rays at posterior end of dorsal fin; anal spines likewise hard and sharp. Vertical fins low, first dorsal spine 2.5 in head; second dorsal uniform in height, 3.18 in head; first dorsal ray equal to first dorsal spine; anal rays of uniform height, 2.9 in head.

Alcoholic specimens uniform yellow, all fins as well as body.

This handsome blenny, previously unknown in the Philippines, is represented by a specimen 61 mm long, from a reef at Paraoir, La Union Province, Luzon. Hitherto known only from Java, from specimens described by Bleeker in 1857.

My specimen is a female, containing very many eyed embryos.

Genus PARACRISTICEPS novum

This genus is separated from *Cristiceps* by the differences in the dorsal and anal fins. First dorsal composed of 2 greatly elongated and threadlike spines; number of dorsal and anal rays or spines greatly increased; second dorsal with more than 45 rays, anal with more than 50. Dorsal and anal fins singularly shaped, their form strongly divergent from that of *Cristiceps*. Anterior dorsal rays very high, forming a triangle, followed by very short rays connecting it with a high posterior part. Anal of similar shape. Caudal free.

A single species, supposed to occur in the Philippines.

Type: *Paracristiceps filifer* (Steindachner).

PARACRISTICEPS FILIFER (Steindachner).

Cristiceps filifer STEINDACHNER, Archiv. Zool. 3 (1864) 199.

Dorsal II, 49; anal 54; caudal 16; ventral I, 3. Scales in lateral line about 60, 12 in transverse series.

Height equal to length of head, 8 times in total length; tentacles none. Snout rounded, cleft of mouth under eye. Jaws with a row of fine pointed teeth, vomer with velvety teeth. Ctenoid scales very deciduous. Over hind part of head 2 dorsal spines of extraordinary length, their height one-third of total length. Opposite these on the throat is the ventral, whose outer ray is similar, its length equal to half the total length. Second dorsal and anal beginning opposite each other, at commencement of second third of total length. First 15 dorsal rays forming a triangle, higher than body; after these, 15 short and hardly noticeable rays, which connect the high forward part with the hinder part of 19 rays only half as high. Anal similar in form; high forward part containing 20, the much shorter middle part 12, hind part 22 rays. Dorsal and anal ending shortly before caudal. Lancet-shaped caudal fin longer than head; caudal peduncle very slender.

Yellow, back showing numerous fine black dots.

The Vienna Museum had 2 specimens, in very bad condition, without definite locality other than the Philippines. Doctor Steindachner also found a colored painting of this species in the Museum, made from a specimen at Bombay.

That this fish occurs in the Philippines is very doubtful.

BLENNIIDÆ

As treated here, this family includes all those elongate naked blennies which have the soft spinous and soft-rayed portions of the dorsal more or less subequal, or else have a dorsal composed of 60 or more flexible spines, without rays, and the tail never 4 to 6 times as long as the head and trunk together. Teeth in a single, close-set, comblike series, fixed or movable. Ventrals jugular, with a spine and 2 to 4 rays. Pseudobranchiæ present.

This family includes a large number of fishes living in shallow coastal waters of tropical and temperate regions, nearly all of them small. A few live at considerable depths, and rarely there are fresh-water species. The great majority are egg-laying.

Most of them are carnivorous, but certain genera feed on algæ. Some species are exceedingly active and go about on exposed rocks at low tide in search of food, moving around with the agility of lizards.

Key to the genera of Blenniidae known from the Philippines and the Sea of Celebes.

- α^1 . Spinous and soft rays of dorsal of nearly equal extent, their combined number always less than 50; tips of teeth never arrow-shaped; depth never more than 9 in length.
- b^1 . Teeth fixed in one row in each jaw.
 - c^1 . Gill opening wide, extending forward below and free from isthmus; a small posterior canine may be present on each side in both jaws, or in lower jaw only..... 1. *Blennius*.
 - c^2 . Gill opening restricted; a pair of stout to very large posterior canines in lower jaw, and a pair of smaller ones in upper jaw.
 - d^1 . Dorsal and anal never both confluent with caudal; gill opening a small slit above upper angle of pectoral base.... 2. *Petroscirtes*.
 - d^2 . Dorsal and anal both attached to caudal and more or less confluent; gill opening extending downward along pectoral base. 3. *Enchelyurus*.
- b^2 . Teeth small, numerous, movable, set on gums.
 - c^1 . A semicircular or oval adhesive disc behind mouth, under lower jaw. 4. *Andamia*.
 - c^2 . No adhesive disc behind mouth.
 - d^1 . A fringe of small tentacles across nape..... 5. *Cirripectes*.
 - d^2 . No fringe of tentacles across nape..... 6. *Salarias*.
- α^2 . Dorsal of 60 or more flexible spines, without rays; teeth fixed, in one row, those of lower jaw with arrowlike tips; depth 15 or more in length 7. *Lembeichthys*.

Genus *BLENNIUS* Linnaeus

Body deep, oblong, compressed, naked; head large, anterior profile nearly vertical or very steep. Mouth with a single row of slender, curved, close-set fixed teeth in each jaw, with a stout canine on each side below, and usually a pair of smaller canines in upper jaw. Gill openings wide, extending forward below, free from isthmus or forming a broad fold across it. Dorsal fin entire, or somewhat emarginate, with slender flexible spines. Lateral line developed only anteriorly.

A genus with numerous species in warm temperate seas, some occurring in the lakes of northern Italy. Only a few species occur in East Indian and adjacent seas. They are all small and dull-colored. Only one species is known to occur in Philippine waters.

BLENNIUS THYSANIUS Jordan and Seale.

Blennius thysanius JORDAN and SEALE, Bull. Bur. Fisheries 26 (1907) 47, fig. 19.

Dorsal 25 to 27 (XII or XIII, 12 to 15); anal 15 to 19 (I, 14 to 17 or II, 15 to 17).

Body very deep, compressed, head as deep or deeper than trunk, snout very steeply inclined to nearly vertical; dorsal and anal free from caudal. Depth 3 to 3.6, head 2.9 to 3.2 (by exception, 3.5), caudal 1.7 to 1.8, pectoral 4, ventral 6 times in length; eye 4.5 to 6, snout 2.6 to 3, least depth of caudal peduncle 3.5 to 3.6, pectoral 1.4, ventral 2.15 to 2.25 times in head; narrow interorbital 3.5 times in eye, eye 1.5 to nearly 2 times in snout. Base of anal fin 1.9 to 2 times in length of dorsal base. There is a short, broad, fimbriate tentacle.

Mouth nearly horizontal, maxillary extending beneath middle or posterior rim of eye, or in old males beyond eye; lower jaw with a pair of canines, upper jaw with a posterior pair of smaller canines. The original description gave 2 canines on each side of the lower jaw, and examination of the type, an old male, showed 2 canines on one side only, evidently an abnormality. The dorsal is not notched, or by exception in old males may have a slight depression on the anterior portion or above the twelfth or thirteenth spine. In males the two anal spines have large bulbous tips, as in most species of *Blennius*.

Dark brown in life, with 6 to 8 darker crossbands sometimes present; sides and under parts of head and pectoral base spotted with paler; dorsal with a dark blotch or band on upper part of dorsal anteriorly and rows of spots all over; anal yellowish, with a submarginal dark band, tip of rays white; caudal and pectorals yellow, latter with a brown spot on lower third.

Alcoholic specimens brown, sprinkled with small dark-brown spots and vertical lines; smallest specimens showing traces of 8 dark crossbands on nape and trunk; dorsal pale brown with rows of darker spots which often disappear; a blackish spot may be present between first and second dorsal spines or between third to sixth spines, or a dark-brown band along upper part of first half dozen spines; other fins little changed.

This little blenny occurs abundantly amid the sponges, hydroids, and mollusks covering the surface of harbor buoys left a long time in the water. The blennies crawl about under the luxuriant growth, where they have an abundance of food and complete protection.

Described from 5 specimens, 27 to 40 mm long, from Puerto Princesa, Palawan; 21 specimens, 41 to 52 mm long, from Catbalogan, Samar; and 26 specimens, 25 to 43 mm long, from Darman Passage, off Leyte. The Palawan specimens diverge rather widely from the type, and at first I called them new. A critical study of the type and the above series proved them all to belong to the same species. Jordan and Seale had 2 examples, 63.5 and 73.5 mm, from Cavite. The type is in the United States National Museum, and the cotype in the Stanford Museum.

Genus PETROSCIRTES Rüppell

Petroscirtes RÜPPELL, Atlas Fische (1837) 110.

Body naked, more or less elongate, with a small or medium-sized head which often has tentacles on the eye, and may also have them on the nape and nostrils; more rarely there are tentacles on the opercular and preopercular margins, on the chin, and on the throat. Snout short, or of moderate length, convex or elongate and conical. Mouth often rather small, but may be rather large and extending to hind margin of eye. Teeth fixed, in one row, with a very large curved posterior canine on each side of lower jaw; upper jaw with a pair of similar but much smaller canines. Gill opening reduced to a small slit or a nearly circular aperture above upper angle of pectoral base. Dorsal fin continuous and undivided, but 2 or 3 anterior rays may be elongated and filamentous so that they are semidetached. Dorsal usually ending on caudal peduncle, before caudal fin, but in a few species extending to base of caudal. Ventrals jugular, composed of 2 or 3 rays. Unlike most blennies, the fishes of this genus have an air bladder.

This group contains numerous species in the tropical portions of the Indian and Pacific Oceans, where they replace the genus *Blennius* of temperate regions. The species of *Petroscirtes* are common on coral reefs throughout, but as a rule those in the Philippines live in deeper water than do the blennies of the genus *Salarias*. However, some species do not move off with the receding tide, but remain in shallow rocky pools or stay on exposed rocks until the incoming tide covers them again.

Unlike *Salarias*, they are carnivorous, and certain species leap about on the rocks with great agility in pursuit of their prey. The name *Petroscirtes*, rock springer, was given by Rüppell because of the activities of a species he discovered in the Red Sea.

When one examines preserved material it usually seems impossible for the fish to ever open its mouth wide enough to use

its preposterously large lower canines. Many have speculated about the use of these huge teeth, which contrast so greatly with the rest of the teeth. Examination of living or fresh specimens, however, shows that the mouth has a surprising gape; as the lower jaw drops, the great canines come out of their hiding places and point forward ready for action. If one handles living specimens he very quickly discovers one use of their canines as they sink them into his fingers. More than a century ago Rüppell saw "rock springers" skipping about over the rocks and impaling their prey with their great fangs.

The 15 species described here are by no means all that are found in Philippine waters. No doubt nearly all that are known from the East Indies and Polynesia will ultimately be discovered in the Philippines. The rock springers are, as a group, shy and elusive fishes, swift of movement and able to hide in tiny rock crevices and inside coral heads. They are therefore not at all easy to collect, but I believe that a little attention paid to them would bring the number of Philippine species of *Petroscirtes* up to 20.

Key to the Philippine species of Petroscirtes.

*a*¹. Marine species.

*b*¹. Dorsal with 35 or more rays, and a median longitudinal band.

*c*¹. Anterior dorsal rays not elongated.

*d*¹. Blue, with black band from snout tip to end of caudal; dorsal and anal black, with white edges; dorsal 38 or 39.

1. *P. tæniatus*.

*d*². Not blue.

*e*¹. Dorsal 44 or 45; brown band from eye to caudal, with blue or white stripe above and below; fins yellow, unmarked.

2. *P. rhinorhynchus*.

*e*². Dorsal 42 or 43; brown, with darker band; dorsal with 7, anal with 5 brown vertical bars; caudal with cross rows of brown dots 3. *P. amblyrhynchus*.

*c*². Anterior dorsal rays elongated, most or all with elongated tips; dorsal 36 to 38; dark-brown band from tip of snout to caudal tip, with a blue or silvery stripe below dorsal base.

4. *P. filamentosus*.

*b*². Dorsal with not more than 32 rays.

*c*¹. Dorsal with 25 to 27 rays; a pair of flaplike tentacles under chin, another on eyes; other tentacles along margins of opercles and preopercles; caudal becoming lunate with age..... 5. *P. mitratus*.

*c*². Dorsal with 27 to 32 rays.

*d*¹. No longitudinal bands or stripes.

*e*¹. No tentacles.

- f*¹. No crossbands or stripes on body. Olive to yellowish, with small brown spots and sprinkled with blue dots; fins yellow, dorsal and anal spotted and striped; dorsal 28; anal 19.
6. *P. bankanensis*.
- f*². Diagonal or angular crossbands on body.
*g*¹. Body with 11 angulated black crossbands, their angles pointing forward; a large black ocellus between the nineteenth and twenty-third dorsal rays..... 7. *P. kallosoma*.
- g*². Eight milk-white diagonal stripes, inclined backward along side, with wider blackish-brown stripes between them; a large black or dark-brown spot behind eye, margined with white lines; brown bands with white margins on throat and chin; dorsal 31 to 33; anal 22 or 23.
8. *P. loxias*.
- e*². Tentacles on eye, throat, nape, and top of opercle; color mottled brown, with whitish or blue spots and dots; fins yellow, barred with red-brown spots or bands; dorsal 27 to 30; anal 17 to 19 9. *P. eretes*.
- d*². Body with one to several longitudinal bands or stripes.
*e*¹. A single broad black or blue-black band from eye to caudal.
10. *P. variabilis*.
- e*². Body with two or more lengthwise bands.
*f*¹. Two or 3 violet-brown bands; upper band from eye to top of caudal base, composed of short vertical violet-brown bars inclined backward..... 11. *P. grammistes*.
- f*². Body with both dark and pearly white, bluish, or yellowish-white bands.
*g*¹. Short, broad tentacles on top of eye and behind upper rim, a pair of small tentacles on nape; a broad purplish-brown band from snout tip to caudal base; below this a pearly white band and below that a narrow dark-brown stripe from chin to caudal base; head, throat, and breast dotted with black..... 12. *P. polyodon*.
- g*². No tentacles on head.
*h*¹. A violet-brown band over eye to middle of caudal and on basal third; above and below this band a yellowish-white band; a very dark stripe along dorsal base and a brown band from chin to caudal..... 13. *P. solorensis*.
- h*². Bluish to pearl, with 3 broad dark red-brown longitudinal bands, second and third band pale brown, with very dark circular spots as large, or larger than interspaces, bands ending before hind end of dorsal; circular dark spots on caudal peduncle and caudal base. Ground color forming bluish or pearly white stripes between dark bands..... 14. *P. temmincki*.
- a*². Fresh-water species from Lake Bombon. Body with about 9 more or less angulate darker vertical bars..... 15. *P. ferox*.

1. PETROSCIRTES TÆNIATUS (Quoy and Gaimard).

Aspidontus tæniatus QUOY and GAIMARD, Voy. Astrolabe Zool. 3 (1834) 719, pl. 19, fig. 4.

Petroscirtes tæniatus GÜNTHER, Cat. Fishes 3 (1861); Fische der Südsee 2 (1876) 195, pl. 114, fig. A; HERRE, Philip. Journ. Sci. 59 (1936) 372.

Dorsal 38 or 39; anal I, 25 or 26.

A specimen 93 mm long, from Calapan, Mindoro, has depth 4.9, head 4.2, truncate caudal 6.6 times in length; snout 3.14, eye 5.5, interorbital 3.4 times in head. Another specimen, 47 mm long, from Taruna, Sangi Island, one of the Sangir Group between Mindanao and Celebes, has depth 5.2, head 3.6, caudal 5.5 times in length. Eye 4.3, snout 3.25, interorbital 4.3 times in head. Mouth inferior, not reaching eye; blunt projecting snout becoming convex with age.

Blue, becoming more or less purplish brown in alcohol, with a black band from tip of snout to tip of caudal fin; narrow over eye but twice as wide on last half of body, covering the entire caudal fin except a narrow margin of blue (which becomes white in alcohol) above and below. Dorsal and anal black, with a narrow white margin.

I have also examined a specimen about 75 mm long at Dumaguete, Oriental Negros Province, and have seen this species at Sitankai, Bungau, Sibutu, and elsewhere in the Philippines.

This fish swims with a peculiar undulating and twisting motion that is very characteristic, swaying from side to side as it glides swiftly along. It is present on all coral reefs throughout the East Indies and Polynesia, but is very difficult to collect. It reaches a length of 126 mm, and is the handsomest blenny in Indo-Pacific waters.

This black-banded blue blenny has a very peculiar habit for which no explanation is yet offered. Very often it maintains its position beneath some much larger fish living on the reef. Like a shadow, the slender gleaming blue blenny twists and turns with every movement of the larger fish, always keeping the same relative position.

2. PETROSCIRTES RHINORHYNCHUS Bleeker.

Petroscirtes rhinorhynchus BLEEKER, Nat. Tijds. Ned. Ind. 3 (1852) 273.

Petroscirtes rhinorhynchus GÜNTHER, Cat. fishes 3 (1861) 230; HERRE, Fishes 1931 Philippine Exp. (1934) 100.

Dorsal 44 to 45; anal 30 to 32.

Head 5.5 to 6.2, depth 6.2 to 8.2, caudal 5.6 to 6.2 times in length. Snout conical, projecting beyond mouth, which ascends

almost vertically; lower canines very large, no canines in upper jaw. Eye 3.5 to 3.9, interorbital 3.2 times in head.

A pale-blue line extending from top of snout above eye to caudal base at top of caudal peduncle; a similar line extending around tip of snout and over lower third of eye to pectoral, and on to lower end of caudal base. Between these two blue lines a broad brown or purplish-brown band, which extends well out on the caudal; a narrow brown band above upper blue line, another below lower blue line; fins all clear yellow.

In alcoholic specimens the blue lines become white.

A specimen I collected at Dumaguete, Oriental Negros Province, is 43 mm long, and 2 specimens obtained at Sitankai are 60 and 69 mm long. In addition I secured a specimen at Waigiu, 31 mm long, and 4 specimens, 33 to 39 mm long, at Madang, New Guinea. This species occurs from the East Indies to the New Hebrides.

3. PETROSCIRTES AMBLYRHYNCHUS Bleeker.

Petroscirtes amblyrhynchus BLEEKER, Act. Soc. Sc. Md. Neerl. 2 (1857) 64.

Petroscirtes amblyrhynchus WEBER, Fische Siboga Exp. (1913) 540.

Dorsal 42 to 43; anal 31.

Two specimens, each 34 mm long, were obtained from the south coast of Cotabato Province. Depth 6.8 (8 with caudal), head 4.25 (5 with caudal), caudal 5.66 times in standard length. Eye 3.45, interorbital 2.75 times in head. Canines of lower jaw stout; my specimens have none in the upper jaw. Snout conical, projecting; mouth inferior, caudal forked.

Alcoholic specimens brown, with traces of a median longitudinal band, extending on basal portion of caudal. Fins clear, dorsal with 7, anal with 5 brown vertical bars, caudal with transverse rows of brown dots; pectoral with a band of blackish dots on base.

I also collected the following: One from Lembeh Strait, 30 mm long, and 1 from Kema, North Celebes, 40 mm long; 1 of 33 mm from Ternate, and one of 32 mm from Manokwari, New Guinea.

This rare species was previously known only from 1 specimen from Amboyna, 1 from Salayer, and 7 from Banda, in the Moluccas.

4. PETROSCIRTES FILAMENTOSUS (Cuv. and Val.).

Blennechis filamentosus CUVIER and VALENCIENNES, Hist. Nat. Poiss. 11 (1836) 280, pl. 326.

Petroscirtes filamentosus GÜNTHER, Cat. Fishes 3 (1861) 231; Fische der Südsee 2 (1876) 196, pl. 114, fig. 5.

Dorsal 36 or 37; anal I, 25 to 27.

Body slender, elongate, much compressed laterally; depth 5.4 to 5.5, head 3.7, caudal 5.85 times in length. Snout conical, projecting well beyond mouth, its length 3.3 to 3.6, eye 4 times in head. Interorbital a little broader than an eye diameter. Mouth small, inferior, not extending back to a vertical from front margin of eye. Canines in lower jaw of moderate size, strongly hooked in a much flattened curve, so that they point backward; canines in upper jaw very small. First four dorsal rays elongated, first and second much the longest, all tips of dorsal rays more or less elongated and threadlike.

Alcoholic specimens violet-brown on upper half and posterior fourth of body, under parts very pale bluish pearl or silvery. A dark-brown band passes from tip of snout over eye and above pectoral base to caudal pit; on head it is about half as wide as eye, but broadens posteriorly so that it covers the caudal except for a narrow white margin above and below. A narrow blue or silvery stripe along back at dorsal base; this has disappeared on one side in my specimen. Dorsal dark violet-brown, with 7 whitish spots along basal half; these were probably blue or pearl-colored in life; anal and ventrals uniform dark violet-brown.

No Philippine specimens have been seen, but I collected an excellent specimen, 41 mm long, on the north coast of Celebes. Any fish occurring there may confidently be expected to occur in the Sulu Islands and on the coast of Mindanao. This easily recognized reef dweller occurs from the Moluccas to the Tuamotu Archipelago.

5. *PETROSCIRTES MITRATUS* Rüppell.

Petroscirtes mitratus RÜPPELL, Atlas Fische (1828) 111, pl. 28, fig. 1; KLUNZINGER, Fische Rothen Meeres pt. 2 (1871) 496; GÜNTHER, Fische der Südsee 2 (1877) 198; FOWLER, Proc. Acad. Nat. Sci. Phila. 89 (1927) 295.

Petroscirtes barbatus PETERS, Wiegmann's Archiv (1885) 248; SAUVAGE, Poiss. Madagascar (1891) 383, pl. 38, fig. 6; HERRE, Fishes 1931 Philip. Exped. (1934) 98.

Dorsal 25 to 27; anal 16 to 18.

Depth equal to or less than head, 3.66 to 4, head 3.4 to 3.66, caudal 4.36 times in length; snout equal to eye, 3.1 to 3.2 times in head. First three dorsal spines more or less elongated, fourth shorter than others, which are of uniform height except the three posterior spines, which are much shorter. Under the chin a pair of broad, flaplike, brownish barbels; on top of eye itself

a similar broad, flat, tentacle which may be slightly fringed; above front margin of eye a small, simple tentacle; immediately behind eye a very small tentacle; much farther back and opposite base of first dorsal spine a very small flap, another on upper margin of opercle; on lower and under margins of preopercle a row of very small flaps, the most anterior one largest. Any one of these opercular and preopercular flaps may be absent. Caudal broadly rounded in my specimens, but with age changing its shape and becoming lunate through growth of upper and lower marginal rays. Canines in lower jaw of moderate size, about 2.5 times in eye; upper canines very small.

Alcoholic specimens light brown, with 5 broad darker purplish-brown bands across body; in top of all except first band a very pale ocellated spot, traces of similar spots on sides; dorsal and anal spotted thickly with dots and blotches of reddish brown; caudal clear.

Three specimens, 13 to 24 mm long, were collected at Puerto Galera, Mindoro. Fowler described 2 examples from the Philippines, without more definite locality, their length "53 and 60 ? mm." Elsewhere this blenny is known from the Red Sea, Mozambique, and Madagascar, to the Caroline Islands and Samoa. It reaches a length of over 75 mm. According to Rüppell it remains out of the water for long periods, chasing its prey of minute crustacea over the rocks.

6. *PETROSCIRTES BANKANENSIS* Bleeker.

Petroskirtes bankanensis BLEEKER, Nat. Tijds. Ned. Ind. 3 (1852) 727.

Petroskirtes amboinensis BLEEKER, Nat. Tijds. Ned. Ind. 4 (1853) 114.

Petroskirtes bankanensis GÜNTHER, Cat. Fishes 3 (1861) 237; WEBER, Fische Siboga Exped. (1913) 540.

A specimen 25 mm long was taken at Cabalian, Leyte. Dorsal 28; anal 19. Depth 5, head 3.8, caudal 4.15 times in standard length. Eye 4 to 4.5 times in head, 1.33 times in interorbital space. This specimen has no canines in the upper jaw, and no tentacles. Lower jaw with a pair of strong canines. Larger specimens have small canines above, and a small tentacle behind the upper margin of the eye. Dorsal origin above hind edge of preopercle.

Olive above, yellowish below, with small brown spots and sprinkled with blue dots, which fade in alcohol. Fins yellow, dorsal and anal spotted with dusky and variegated with reticulated lines or stripes of dusky. Caudal unmarked.

Bleeker had a specimen, 120 mm long, from Banka. He also obtained it from Singapore and Nias, and Doctor Weber secured it from several places in the East Indies.

7. *PETROSCIRTES KALLOSOMA* Bleeker. Plate 2.

Petroskirtes kallosoma BLEEKER, Nat. Tijds. Ned. Ind. 15 (1858) 227.

Petroskirtes kallosoma WEBER, Fische Siboga Exp. (1913) 541.

Dorsal 30 to 32; anal II, 18 to 21.

Greatest depth at dorsal origin, which is over the gill opening. Depth 6, head 4.6, caudal 3.3 times in length. Eye 3.25, snout 4.33 times in head. Upper and lower rays of caudal prolonged.

Alcoholic specimens dark brown, with black spots on lower half of head, breast, and pectoral bases. On the body are 11 angulated black crossbands, their angles pointing forward, with a black spot on each angle. Dorsal brownish, with pale or white longitudinal lines, and a large black spot above between nineteenth and twenty-third rays; anal reddish brown, becoming darker marginally, tips of rays white; caudal pale, tinged with dusky.

Two specimens, each 30 mm long, were collected at Nasugbu, Batangas Province.

This blenny is known elsewhere only from Billiton, Bima, and North Celebes, in the East Indies.

8. *PETROSCIRTES LOXIAS* (Jordan and Seale).

Hypleurochilus loxias JORDAN and SEALE, Proc. U. S. Nat. Mus. 28 (1905) 802, fig. 20.

Petroskirtes loxias HERRE, Fishes 1931 Philip. Exped. (1934) 98.

Dorsal 31 to 33 (XII, 19 to 21); anal I, 21 or 22; pectoral 13; caudal 13.

Depth 5.6 to 6, head 4.25 to 4.35, rounded caudal 6.4 to 6.5 times in length. Eye 4.3 to 4.45, snout 3.2 to 3.4 times in head; interorbital width a little more or less than half of eye. Mouth extending beneath middle of eye, with 24 teeth in both upper and lower jaws; a large stout canine on each side of both upper and lower jaws, or those of upper jaw quite small.

Alcoholic specimens brown to yellowish brown, with 8 conspicuous milk-white diagonal or curved stripes inclined backward along side; between them equally conspicuous wider blackish-brown stripes; both kinds of stripes shorter posteriorly, followed by 2 irregular brown spots on caudal peduncle; often white stripes fading to pale brown. Across back 7 or 8 double

crossbars of blackish brown, which extend as spots on base of dorsal fin. Alternating with stripes a row of blackish-brown spots along upper part of side. From front and back of eye 2 white-margined brown bands passing under chin and uniting with those of other side. Behind eye a highly characteristic and conspicuous black or very dark-brown spot, margined with milk-white lines that extend down across the check and opercle. Fins all clear and colorless except anal, which has a basal row of dark-brown spots and a dark-brown submarginal band, tips of rays white.

I have collected specimens of this very well-marked and handsome species as follows: two from Nasugbu, Batangas Province, 28 and 35 mm long; 1 of 26 mm from Culion; 2 from Opon, Mactan Island, 30 and 39 mm; 2 from Bais, Oriental Negros Province, 27 and 29 mm; 3 from Dumaguete, Oriental Negros Province, 29 to 33 mm; and 1, 45 mm long, from Sitankai. It also occurs on reefs at Singapore.

9. *PETROSCIRTES ERETES* Jordan and Seale.

Petroscirtes eretes JORDAN and SEALE, Proc. U. S. Nat. Mus. 28 (1905) 801, fig. 19; Bull. Bur. Fish. 26 (1907) 47; JORDAN and RICHARDSON, Bull. Bur. Fish. 27 (1908) 283; HERRE, Fishes 1931 Philip. Exped. (1934) 98; Bull. Raffles Mus. No. 13 (1937) 48.

Petroscirtes vulsus JORDAN and SEALE, Bull. Bur. Fish. 26 (1907) 47, fig. 20.

Dorsal 27 to 30; anal II, 15 to 18.

Depth 4.5 to 5, head 4 to 4.2, caudal 1.1 times in length. Eye 2.5 to 3.75 times in head. Body elongate, compressed, with a long convex snout. Mouth extending back beneath pupil, with a pair of large strong canines in lower jaw and a pair of much smaller ones above.

A small and rather broad simple tentacle at top of each eye, a pair of slender simple tentacles on throat some distance from chin, a pair of minute simple tentacles on nape, a similar pair on upper margin of opercle. Last-named two pairs may be broad flaps, and either pair may lack one member.

Alcoholic specimens mottled brown, with whitish spots and dots which are blue in life. Five broad vertical brownish or dusky bands across sides of body, which are often indistinct or disappear in preservative. Dorsal barred by longitudinal rows of reddish-brown spots on first half, and diagonally downward and backward rows on second half; anal with 4 or 5 vertical or

diagonal brown bands, and may be spotted as well. The yellow caudal may also be cross-barred with brown spots. Dorsal and anal both with outer margin yellow.

The Stanford University museum contains the type of *P. vulsus*, 45 mm long, from Manila, and two cotypes of *P. eretes*, 37 and 81 mm long, from Bais, Oriental Negros Province. The following Philippine specimens were also examined: One of 41 mm from Culion; 1 of 62 mm from Cuyo, Palawan; 5 from Dumaguete, Oriental Negros Province, 25 to 50 mm long; 1 of 62 mm from Magallanes, Sorsogon Province; 1 of 28 mm from Nasugbu, Batangas Province; 8 from Puerto Galera, Mindoro, 25 to 59 mm long; and 1 of 21 mm from Sitankai. In addition, I collected 4 in the Pelew Islands, 65 to 70 mm long, and 7 at Singapore, from 44 to 66 mm long. The distribution is as given above.

10. *PETROSCIRTES VARIABILIS* Cantor.

Petrosirtes variabilis CANTOR, Cat. Malayan Fishes (1850) 200; DAY, Fishes India (1876) 327, pl. 69, fig. 7.

Dorsal 28 to 31; anal II, 17 to 19, or I, 19.

Depth 5 to 6.4 times, head 3.6 to 3.7, caudal 4.5 to 5 in length; young have caudal 6 times in length. Eye 4 to 5, snout 3.3 to 3.55 times in head; interorbital width equal to eye, or 1.5 times eye.

Snout truncate, longer than eye, mouth terminal, in large specimens extending to a vertical from front margin of pupil; lower canines very strong, three-fourths as long as eye; upper canines very small. A very small, simple tentacle on upper rim of eye, some specimens also with a pair of very small, flat tentacles some distance behind chin.

Alcoholic specimens reddish brown, often with a bluish cast; a broad black or bluish-black band extending from eye to caudal, with a black or dusky bar across caudal base. Dorsal and anal yellow, rays with diagonal rows of black spots; caudal yellow, may also be barred with rows of dusky spots.

Some specimens are so faded as to be almost uniform brown, with only a trace of the black median band on the basal portion of the caudal, which is densely sprinkled with black dots.

A specimen 36 mm long was collected on the south coast of Cotabato Province, near Kling. I also collected 1 specimen of 85 mm at Sandakan, British North Borneo, and 6 from 44 to 71 mm long on a reef at Singapore. This blenny occurs from the Philippines to India.

11. PETROSCIRTES GRAMMISTES (Cuv. and Val.).

Blennechis grammistes CUVIER and VALENCIENNES, Hist. Nat. Poiss. 11 (1836) 210.

Petroscirtes grammistes GÜNTHER, Fische der Südsee 2 (1877) 197, pl. 115, fig. F; MEYER, An. Soc. Esp. Hist. Nat. Madrid 14 (1885) 31; EVERMANN and SEALE, Bull. Bur. Fish. 26 (1907) 104.

Petroskirtes anema BLEEKER, Nat. Tijds. Ned. Ind. 3 (1852) 273.

Petroscirtes anema MEYER, An. Soc. Esp. Hist. Nat. Madrid 14 (1885) 31.

Dorsal 28 to 30; anal I or II, 16 to 18. Depth contained 7, head 4.6, caudal 3.5 times in length; eye 3.8, snout nearly vertical, 4.6 times in head; interorbital 1.5 times in eye. Dorsal origin immediately behind rear margin of eye; lower canines of moderate size, their length about one-third of eye; upper canines very small. Large specimens with a pair of small filamentous tentacles on throat, a very small pair very close together on nape, another very small pair on upper margin of opercle.

A band composed of short, vertical, violaceous-brown bars, inclined backward, passing from eye to upper end of caudal base, then bending toward middle, extending centrally half length of caudal; a similar diagonal stripe running back on caudal from lower end of base; a violaceous-brown band along dorsal base merging on caudal peduncle with band below it; a third dark-violet band present in life above anal but in preserved specimens often largely disappearing, leaving only portion mentioned on caudal; anterior dorsal rays entirely dark brown, rest of dorsal clear except basally; anal with a marginal brown line.

Philippine specimens were examined as follows: One from Subic, Zambales Province, 53 mm long; 2 from Puerto Galera, Mindoro, 24 and 53 mm long; 2 from Legaspi, Albay Province, 38 and 50 mm long; 2 from Dumaguete, Oriental Negros Province, 37 and 44 mm long. I also collected a specimen 54 mm long at Singapore. This species has been collected previously in the Philippines at Bacon, Sorsogon Province, and at Cebu. Elsewhere it occurs from Java to Yap.

12. PETROSCIRTES POLYODON Bleeker.

Blennechis polyodon BLEEKER, Nat. Tijds. Ned. Ind. 1 (1851) 254.

Petroscirtes polyodon GÜNTHER, Cat. Fishes 3 (1861) 235.

Dorsal 28 to 30; anal II, 16 to 18.

Depth 4.25 to 4.5, head 3.5 to 3.75, caudal 4.8 to 5.2 times in length; interorbital width equal to eye, 3.5 times in head; snout broad, convex, a little longer than eye; mouth terminal, cleft extending beneath front margin of eye; strong canines in lower

jaw half as long as eye; those of upper jaw about one-sixth eye diameter. On upper part of eye a short broad flap, and a similar tentacle right behind it, behind rim of eye; a pair of small tentacular flaps may be present on nape.

Alcoholic specimens light brown, with a broad, dark, more or less purplish-brown band from tip of snout to caudal base; below this a pearly white band, likewise extending from snout tip to caudal base, and below this is a narrow dark-brown stripe from chin to caudal base; sides of head, throat, and breast dotted with black, or head and dorsal portion of trunk mottled with paler and dusky brown. Dorsal dotted with brown, most specimens with a pale longitudinal stripe on upper part; on anal 5 dark-brown bands, which extend a short distance on body above.

I collected 13 specimens, 13 to 53 mm long, from a reef near Dumaguete, Oriental Negros Province. Previously known from Java, Celebes, and Amboyna. Bleeker had a specimen 87 mm long from Batavia, Java.

13. PETROSCIRTES SOLORENSIS Bleeker.

Petroskirtes solorensis BLEEKER, Nat. Tijdschr. Ned. Ind. 4 (1853) 81.

Dorsal 30, anal 20; depth 5.33, head 4, caudal 5 times in length; snout convex, equal to eye, 3.4, interorbital 3.8 times in head; lower canines robust, more than half eye, upper canines very small, 10 or 11 times in eye; dorsal origin over posterior margin of opercle.

A violaceous-brown band passing over eye to middle of caudal and out for a third of its length; a yellowish-white band from upper margin of eye to caudal and one from upper lip to caudal; a very dark violaceous-brown stripe along dorsal base to caudal and a brown band from chin to caudal base, the two last-named converging on caudal to central band; dorsal brown, with three rows of darker-brown spots; anal brown, more or less clouded.

The following were examined from the Bureau of Science collection: A specimen 58 mm long from Clarendon Bay, Balabac; 1 of 34 mm from Cabalian, Leyte; and 1 of 75 mm from South Ubian, Sulu Archipelago.

In life the South Ubian specimen had a blackish-green band from the tip of the snout through the eye to the caudal, ending in a conspicuous spot on the caudal base; a yellow band above and below the median band; a black band along the dorsal base, and another from the angle of the mouth to the tail.

Previously known only from Solor, one of the Lesser Sunda Islands.

14. PETROSCIRTES TEMMINCKI Bleeker.

Petroscirtes temmincki BLEEKER, Nat. Tijdschr. Ned. Ind. 2 (1851) 243.

Dorsal 30 or 31; anal I, 15.

Depth 4 to 4.7, head 3.8 to 4 times in length. With age the upper and lower marginal rays of the caudal fin become elongated and threadlike, so that the length of the caudal fin is then 3 to 4 times in the head and body together. Eye 3.25 to 3.5, snout 3.7, breadth of interorbital 4 times in head. There are no tentacles. Profile boldly convex from dorsal origin to terminal mouth, which extends to beneath front margin of eye. Lower canines strong, half or more than half as long as eye; upper canines very small.

Pale blue to pearl, with three broad, dark, reddish-brown or violet-brown bands along side; first running from interorbital along back just below dorsal to its posterior end; second passing around snout and across eye, ending a little before hind end of dorsal; third running from tip of lower jaw back to pectoral, forming a large circular spot on its base; it then continues from the pectoral axil back to the caudal peduncle. Second and third band formed of a paler-brown stripe on which are very dark circular spots, as large or larger than interspaces; similar spots on caudal peduncle and caudal base, forming a characteristic recognition mark. Ground color appearing as bluish or pearly white stripes between dark-brown bands. Dorsal fin brown below, with a submarginal blackish-violet stripe or row of spots, middle of fin bluish or pearly. Anal yellowish, with one or two rows of violet-brown dots between rays; yellow caudal with a dark violet-brown upper margin and sprinkled with rather large dark-brown spots on rays.

Four specimens were obtained at Cebu, 48 to 61 mm long. Elsewhere the species is known from the Moluccas and Singapore.

15. PETROSCIRTES FEROX Herre. Plates 3 and 4.

Petroscirtes ferox HERRE, Philip. Journ. Sci. 34 (1927) 277, pl. 3, figs. 2 and 3.

Dorsal 32 to 36, mostly 33 or 34; anal 24; pectoral 12; caudal 12, not counting the short accessory rays; ventral 2.

Body wedge-shaped, elongate, laterally compressed, its greatest depth just back of pectoral base, 5.5 to 6 times in length; caudal rounded, equal to depth; dorsal profile nearly horizontal, highest at origin of dorsal and descending at a very slight angle in a straight line to caudal base; ventral profile strongly convex below head and belly, then ascending in a moderate straight incline to caudal base; upper anterior profile of head boldly convex; eye 3.66 to 4 times in head, equal to steeply curved snout; interorbital width equals half or two-thirds eye; mouth low down, inferior, apparently very small, lip concealing its posterior angle which is beneath anterior margin of eye; 16 to 18 teeth in upper jaw, 18 in lower jaw; a long, stout, recurved canine tooth on each side of both jaws, lower canines much the larger, their length equal to or greater than diameter of pupil of eye; no tentacles or barbels; dorsal and anal extending to, but not upon caudal; dorsal of almost uniform height, equal to or greater than an eye diameter in vertical height, posterior rays elongate and equal to depth.

Alcoholic specimens varying from light brown to brownish green or brownish gray, underparts paler, body crossed by about nine darker vertical bars; often bars, especially forward ones, angled, point of angle directed forward; dorsal, anal, and caudal uniform dark brown, or concolorous with body; pectoral pale, ventrals whitish.

Here described from 60 specimens, 31 to 56 mm long, from the vicinity of Ambulong, Talisay, and around Volcano Island, all in Lake Bombon. They live amid stones and gravel. When held in the hand they will snap at skin or finger nails and hang suspended by their teeth.

This little blenny is the only fresh-water species known from the Philippines.

Genus *ENCHELYURUS* Peters

Enchelyurus PETERS, Monatsber. Akad. Wiss. Berlin (1868) 268.

This genus is closely related to *Petroscirtes*, but differs as follows: (a), the dorsal and anal are both united to and more or less confluent with the caudal; (b), the gill opening is wider, extending downward as far, or nearly as far, as the lower end of the pectoral base.

A small genus, containing 4 or 5 inconspicuous species found in the East Indies and tropical Pacific. Two species are known from the Philippines. It is possible that the discovery of additional species, or the study of very large series of known species,

may show the genus to be a synonym of *Petroscirtes*. The differences which separate *Enchelyurus* and *Petroscirtes* are not profound, and the examination of very large numbers of various species of both groups may show transitional stages, thus eliminating *Enchelyurus*.

Key to the Philippine species of Enchelyurus.

- a*¹. Uniform black or blackish brown, or with caudal, pectorals, and ventrals yellow or pale; dorsal 31 to 33; anal II, 20; pectoral 16.... *E. flavipes*.
*a*². Everywhere indigo to blue-black, with 2 rows of sky-blue spots along sides, on dorsal, and anal; dorsal 28; anal II, 18; pectoral 13.
E. caeruleo-punctatus.

1. **ENCHELYURUS FLAVIPES** Peters.

Enchelyurus flavipes PETERS, Monatsber. Akad. Wiss. Berlin (1868) 268; HERRE, Bull. Raffles Mus. No. 13 (1937) 47.

Enchelyurus flavipes var. *nigerrima* M. WEBER, Fische Siboga Exped. (1913) 545; HERRE, Fishes 1931 Philip. Exped. (1934) 98.

Dorsal 31 to 33; anal II, 20; pectoral 16; ventral 2.

Depth 4.65 to 5.5, head 3.9 to 4, caudal 5 to 5.35, broadly rounded pectoral 5.35 to 5.5 times in length. Eye 4.25 to 5, convex and nearly vertical snout 5 times in head. Angle of mouth beneath hind margin of eye; a very large posterior canine on each side in lower jaw, a smaller pair in upper jaw. Caudal rounded to somewhat pointed. Ventrals 6 to 8 times in length in young, but they become elongated with age; in females they nearly reach the anus, but in mature males they may extend upon the anal fin, 3.7 to 4 times in length. Dorsal undivided, increasing in height posteriorly; tips of anal rays more or less enlarged posteriorly.

Typical form uniform blackish brown or black, including vertical fins, with an elongate yellow spot covering most of caudal fin; rarely yellow may extend forward to include rear end of body and adjacent parts of dorsal and anal. Dorsal with a narrow white or pale margin, usually covered by parallel pale lines (blue in life?) on upper part of anterior half; sometimes they are on the lower part also, more rarely absent. Tips of anal rays white, anal with 2 to 4 faint pale-blue longitudinal lines. Pectorals and ventrals yellow. In alcoholic specimens the yellow fades to white or colorless.

My only Philippine specimen belongs to the variety *nigerrima*. It is 33 mm long, entirely black, body and all fins with longitudinal lines previously mentioned on dorsal and anal; taken by me at Culion.

Peters had 2 specimens of the typical form, each 60 mm long, collected at Singapore.

Dr. Max Weber described the variety *nigerrima* from 2 specimens, 62 and 75 mm long, taken near Makassar.

The only other specimens of this species known are 21 examples of the typical form, 36 to 59 mm long, which I collected from a reef at Singapore.

2. *ENCHELYURUS CÆRULEO-PUNCTATUS* sp. nov. Plate 1.

Dorsal 28; anal II, 18; pectoral 13; caudal 13.

Depth 4.5, head 4.15 to 4.2, caudal 5.4, pectoral 5 times in length; ventral equal to pectoral, not reaching anus. Eye equal to snout, 3.6 to 3.7, depth of caudal base 2.5 times in head. Eyes very close together, interorbital breadth 5 times in an eye diameter.

Body laterally compressed, dorsal profile horizontal, ventral outline in an arc, depth greatest at dorsal origin, which is over the opercle; snout convex, nearly vertical; mouth small, its angle beneath front rim of eye; a pair of stout canines in lower jaw, those of upper jaw half as large; small gill opening above and in front of pectoral base, equal to diameter of eye; dorsal and anal both attached to caudal base, but not completely confluent with it, as in other species of genus.

Head, body, dorsals, anal, and caudal very deep indigo or blue-black, with 2 rows of small sky-blue spots on side, median row beginning at upper angle of opercle, the other behind lower part of pectoral; 2 similar rows on dorsal and anal, and 2 or 3 cross rows on caudal; tips of dorsal and anal rays pale.

The type, 30 mm long, and paratype, 27 mm long, were collected from a tide pool among the rocks at Nasugbu, Batangas Province, Luzon. The gill opening extends downward below the middle of the pectoral base. A very handsome little blenny in life.

Genus *ANDAMIA* Blyth

Andamia BLYTH, Journ. Asiat. Soc. Bengal (1859) 270.

This remarkable genus differs from *Salarias* in having an adhesive disc or sucker on the lower jaw, immediately behind the mouth. Caudal rays not branched. Head broad, somewhat depressed anteriorly; eyes small, dorsolateral in position and from an eye diameter apart in the young to nearly 2 diameters apart in adults. Males have dorsal rays more or less elongated, especially anterior ones. Orbital tentacle present.

Very active slender fishes living on exposed rocks on the outer reefs and surf-beaten coasts, and spending a great deal of time out of the water. Two species are known. One species occurs from the Nicobar Islands and Andamans to the Moluccas, the other is found from the Philippines through the East Indies to New Guinea.

ANDAMIA REYI (Sauvage).

Salaria reyi SAUVAGE, Bull. Soc. Philomat. IV (1880) 219.

Andamia cyclocheilus M. WEBER, Fische Siboga Exped. (1913) 533, pl. 3, fig. 3; HERRE, Philip. Journ. Sci. 59 (1936) 370.

Dorsal XV, 19 or 20; anal 24 to 26.

Depth 7.33, head 5.5, caudal 3.3, pectoral 5 times in length; eye 3, snout 2.4, interorbital 4, ventral 2.4 times in head. Second and third dorsal spines a little elongated. There is a fimbriated ocular tentacle.

Large males have the anterior dorsal spines, or all the dorsal spines except the first, much elongated. Caudal rays undivided, tips filiform, free. A male 77 mm long has depth equal to head, 6 times, caudal 3.35, pectoral 5.1, ventral 11, second dorsal spine 3.2 times in length; eye and interorbital equal, 4.33 times, snout and ventral each 1.85 times in head.

Alcoholic specimens uniform purplish brown or blue-black, with or without 10 to 12 paler violet or whitish spots and short irregular bars over head, back, and sides; dorsal, caudal, and pectoral brown, brownish black, violaceous, or colorless; anal may be colorless, or blackish-blue with white margin; ventral white.

From *Andamia expansa* Blyth this species is separated by the shape of its adhesive sucker, which is a semicircular or oval disc behind the mouth, instead of the double-pointed one of *A. expansa*.

I have collected Philippine specimens as follows: One of 25 mm at Nasugbu, Batangas Province; 1 of 50 mm at Layia, Batangas Province; 1, 58 mm long, at Calapan, Mindoro; 4, 48 to 66 mm long, at Puerto Galera, Mindoro; and 1, 61 mm long, on the south coast of Cotabato Province. I also obtained 3, 46 to 56 mm long, at Taruna, Sangi Island, in the Sagir group; 20, from 28 to 77 mm long, at Lembeh Strait, Celebes; and 1, 63 mm long, on the coast of Sarawak, Borneo. Sauvage had a specimen 70 mm long, collected by Mantano and Rey on the coast of Tayabas Province.

Weber had a specimen from New Guinea, 3 from Flores, and one labeled "East Indies." It is not rare, as has been hitherto supposed, but is common enough if one knows where to look for it.

This extraordinary slender little blenny lives on the outer face of rocks jutting into the sea, and scampers or leaps about as actively as a lizard. Its adhesive disc enables it to cling to vertical rocks above the water. Although it lives where the water is constantly in motion and highly aerated, it seems to need more oxygen and hence takes to the air. It is as keen-eyed as *Periophthalmus barbarus*, or *Periophthalmodon schlosseri*, and at the first sight of a human being, bird, or other enemy, bounds off, usually into the water, and hides in a crevice. This species evidently occurs commonly in suitable places from the shores of Celebes to the coast of Luzon, but is very rarely taken because of its excellent vision and great agility. The only way I have been able to take these fishes has been by wading out along the side of some rock where they were hanging above the water. Then with a long-handled dip net in hand, I would step out in front suddenly and make a wild dash with the net before all could escape. In this way I have secured them in Celebes and in the Philippines.

Key to the East Indian species of Cirripectes.

*a*¹. Yellow to light brown, with dark-brown spots on head and forward part; dorsal and pectoral brown-spotted. Dorsal XII, 12; anal II, 13.

C. caninus.

*a*². Body and fins black to dark brown; dorsal XI or XII, 15; anal I or II, 15 or 16 *C. variolosus.*

1. CIRRIPECTES CANINUS Herre.

Cirripectes caninus HERRE, Philip. Journ. Sci. 59 (1936) 284.

Dorsal XII, 12; anal 15, ventral 3; pectoral 15. Head equal to depth, 3.28 times in length; caudal 4.6, pectoral 2.875 times in length; eye 2.9, snout and interorbital each 3.5 times in head; depth of caudal peduncle equal to eye; ventral 1.75 times in head.

Body compressed-ovate, deepest just behind pectoral base, anterior profile descending at an angle of about 45° from over eye to tip of snout. Mouth small, its angle beneath front margin of eye. Lower jaw with 4 hooked canines near symphysis, with a single row of very small teeth behind them; upper jaw teeth similar, canines much smaller.

On nape a row of 26 tentacles, some of them broad and bifid. On anterior nostril a short, broad, fringed tentacle; none on eye

or elsewhere. Dorsal entirely free from caudal, latter rounded, its central rays longest.

Yellow, with large brown spots between pectoral and dorsal, and small brown spots all over head and on pectoral base; 10 blackish-brown spots or vertical bands on dorsal; brown spots on pectoral, tips of rays black; other fins colorless. After some years in alcohol the yellow has become light brown.

The type and only specimen, 22 mm long, was taken by me with an electric light at Ternate, one of the Moluccas. This blenny may be expected around the Sarangani Islands, on the south coast of Mindanao, and among the Sibutu Islands.

2. *CIRRIPECTES VARIOLOSUS* (Cuv. and Val.).

Salarias variolosus CUVIER and VALENCIENNES, Hist. Nat. Poiss. 11 (1836) 317, pl. 330; GÜNTHER, Fische der Südsee 2 (1877) 203, pl. 116, fig. A.

Cirripectes variolosus SWAINSON, Nat. Hist. 2 (1839) 275; FOWLER, Fishes Oceania, Mem. Bishop Mus. 10 (1928) 434; HERRE, Fishes 1931 Philip. Exped. (1934) 100.

Dorsal XI or XII, 15; anal II, 16.

Depth 3.15, head 3.3 to 3.4, caudal 3.75 times in length. Eye 4.25 to 4.4, snout 2.75 to 2.8 times in head.

Strongly compressed, with rather broad head, anterior profile convex with vertical or nearly vertical snout; eyes prominent, projecting upward, and with a slender tentacle of 2 long slender threads on the upper margin. On nape a long row of short filaments; nasal filaments fringed and rather long. Upper lip crenulate or finely scalloped; a stout canine on each side of lower jaw. Dorsal high, anterior rays often very long with threadlike tips, more or less attached to caudal. Large specimens have anal spines much thickened and bulbous, their surface gyrose.

All black or deepest chocolate brown, with elongated dorsal spines and upper and lower parts of caudal more or less colorless; alcoholic specimens may fade to dull uniform brown, fins remaining black.

I collected the following Philippine specimens: three from Dumaguete, Oriental Negros Province, 44 to 66 mm long; 2 from San Juan, Siquijor, 38 and 42 mm long; 2 from Sitankai, 65 and 74 mm long. I also obtained 2 young specimens, 16 and 31 mm long, at Waigiu. The Stanford Museum has 5, from 40 to 46 mm long, from Apia, Samoa.

This little blenny is found all over the tropical Pacific. It reaches a length of 92 mm.

Genus *SALARIAS* Cuvier

Body usually slender and elongate; skin naked, lateral line little developed. Movable teeth numerous, implanted on gums; a pair of curved canines, often long and strong, may be present on posterior part of lower jaw; simple or fringed tentacles may be present on eye, nape, and nostril. A median longitudinal skinny crest may be present on top of head; it is found on males only, except in two or three species. Philippine specimens with crests may be safely regarded as males; some species never have a crest. Dorsal rather high and may be entire, but usually more or less deeply notched between spinous and rayed portions; it may be free from the caudal or more or less attached to it. Jugular ventrals consisting of a spine and 2 or 3 rays. Gill opening wide, forming a free fold across isthmus.

Herbivorous fishes common on reefs and rocky shores in all warm seas, numerous species in the tropical Pacific. Most members of the genus are very agile, and well deserve their name of rock skippers, or lizard skippers. When the tide goes out they remain in rock pools, or on exposed rocks, where they browse on algæ. Some species leap about with all the speed and agility of lizards. They lack the brilliant and vivid colors of many small coral-reef fishes, the red, orange, yellow, blue, violet, crimson, and green of butterfly fishes, labrids, and damsel fishes. Nevertheless they are often very handsome, with rich quiet harmonious colors in various shades and markings of brown, gray, reddish, bluish, purplish, and black. To see them at their best, and to gain some idea of their life and habits, one should visit some bold and rocky coast, approaching cautiously, at low tide, small but rather deep pools in the rocks and observing the rock skippers. Some will be clinging quietly to the walls of the pools and some swimming about; almost certainly some will be moving around out of the water. Usually several species may be seen in a pool, and the different behavior of various species compared. Whoever makes an attempt to catch some, will form a new conception of the astonishing physical powers of some fishes, and the limitations of man. To see a rock skipper go bounding away in great flying leaps to deep water and safety, or jump from one roughness to another as it surmounts a nearly vertical ledge of rock a meter and a half high and then with a few great skips is gone into the surf, is to witness one of the most surprising and unfishlike performances in the world.

The identification of rock skippers is often very difficult. The characteristic colors and markings of many kinds often change or disappear very quickly after death, while many species of very different appearance come to look alike after being in preservative for a time. To determine them it is necessary to examine a large series of both fresh and preserved material. The number of dorsal and anal spines and rays, the shape and extent of the dorsal, and the development of the tentacles and crest will usually make it possible to name specimens without difficulty if a goodly number are available for study and comparison. Fortunately a few well-marked and strongly characterized species never lose their identification marks.

The 19 species of *Salarias* here mentioned are by no means all that live in Philippine waters. Further collecting will unquestionably reveal most of those known from the Dutch East Indies. I do not doubt the occurrence of at least 25 species of *Salarias* in the Philippines, and the number may prove to be greater.

Key to the Philippine species of Salarias.

*a*¹. Dorsal not notched.

*b*¹. Body uniformly dark brown or black; fins all dark or caudal yellow; dorsal and anal elongate posteriorly, sometimes for half or three-fourths of caudal length; dorsal 29 to 81; anal II, 18 or 19.

1. *S. fuscus*.

*b*². Not uniformly dark brown or black.

*c*¹. Dorsal attached to caudal.

*d*¹. Brown, thickly sprinkled with blue-black dots; dorsal and caudal with cross rows of spots and bars; no canines; broad, palmately fringed tentacles on eye and nape; dorsal 29 or 30; anal I, 18 or 19 2. *S. ceramensis*.

*d*². Seven wide, dark crossbands; black dots and dashes above pectoral, passing into longitudinal lines along side; large circular white or pale spots below lines and on pectoral base; broad fringed tentacles on eye, nape, and nostril..... 3. *S. fasciatus*.

*c*². Dorsal free from caudal; 2 or 3 rows of elongate brown-edged white spots on sides and small circular ones on head; no violet or blue spots on throat; small canine in lower jaw; minute tentacles on eye and nape; dorsal XII or XIII, 19 to 22; anal II, 22, or I, 23.

4. *S. nitidus*.

(*S. albobuttatus*, a Polynesian species, has a large violet-brown or dark spot on each side of the throat.)

*a*². Dorsal more or less deeply notched.

*b*¹. A longitudinal crest along top of head.

*c*¹. Dorsal XV, 19; anal II, 20; a stout, marginally fimbriate, orbital tentacle and fringed nasal tentacle; uniform light brown with 8 broad, dark crossbars, divided below, and a basal caudal band.

5. *S. colei*.

c². Dorsal with XII or XIII spines.

d¹. Two rows of short blue or pearly bars on sides; a circular blue-black spot at upper angle of opercle; a blue bar below and a blue spot behind eye, often turning black; dorsal XII, 20 or 21; anal I or II, 20 or 21; a long simple orbital tentacle.

6. Males of *S. periophthalmus*.

Also with 4 to 8 longitudinal brown lines along middle of side.

S. periophthalmus var. *visayanus*.

d². Without rows of blue or pearly bars on side.

e¹. Five to seven dark or black longitudinal lines on sides.

f¹. Pale brown, with 5 to 7 very dark lines along sides, breaking posteriorly into dots and dashes; a small orbital tentacle; canines present or absent in lower jaw.

7. Males of *S. caudolineatus*.

f². Brown or leaden, with 5 to 7 darker lines along sides; not breaking up posteriorly, crest low; no canines; orbital tentacle finely fringed, and a smaller nasal one; dorsal XII, 23 or 24; anal II, 23 or 24..... 8. Males of *S. lineatus*.

e². Without several parallel dark lines along sides.

f². Sides with many violet crossbands, wider than interspaces, breaking up into irregular vertical lines posteriorly; no canines; orbital tentacle three-fourths of eye, simple or fringed; nasal tentacle small; dorsal XIII, 19 to 21; anal I, 21 or 22, or I or II, 19 or 20..... 9. *S. oorti*.

f². Not as above.

g¹. Dorsal XII or XIII, 17 or 18; anal I or II, 16 to 18; 7 or 8 broad, forked, dark crossbands, extending on basal half of dorsal; 2 rows of white dots on sides; similar blue dots on top of head, all dots usually brown in preserved specimens; orbital tentacle simple or fringed, and minute fringed nasal tentacle..... 10. *S. bilineatus*.

g². Dorsal XII or XIII, 19 to 22; anal I or III, 20 to 24; dorsal attached to caudal.

h¹. Dorsal XIII, 19 to 21; anal I, 20 to 22; nape and orbital tentacles small; nasal tentacle very small, usually composed of 4 filaments; uniform brown, or with darker crossbars; anal with 2 rows bluish spots, or uniform; a diagonal dark bar behind eye, often disappearing.

11. Males of *S. edentulus*.

h². Dorsal XII or XIII, 20 to 22; anal I, 23 or 24, or II, 21 to 24, or III, 22; orbital tentacle equal to or more than eye, tip and marginal filaments white or pale; 7 double brown crossbars, 2 rows brown dots on lower half posteriorly; dorsal, caudal, and anal white-margined 12. Males of *S. zamboangæ*.

b². No crest on head.

d¹. Upper lip crenulate or denticulate.

e¹. Dark lines from eye over snout, sides of head, and throat; no tentacles on nape; dorsal XIII, 15 to 17; anal I, 17 to 19 or II, 16 or 17 13. *S. frenatus*.

- e*². Sides brown mottled, with row of white spots just below median line; a black spot above pectoral base and black streak behind eye; dorsal XII or XIII, 14 to 16; anal I or II, 16 or 17.

14. *S. marmoratus*.

*d*². Upper lip entire.

- f*¹. Dorsal with less than 19 rays.

*g*¹. A purplish or brown spot or ring on each side of throat; body pale brown, or with double white crossbands, forked below; black dots in irregular rows on sides, or a row of 17 to 19 below dorsal; 1 or 2 large circular white or pale spots on pectoral base; 2 irregular rows or white spots on lower half of head and body; canines absent or present. Dorsal XII or XIII, 17 or 18; anal I, 18 or 19.

15. *S. guttatus*.

*g*². Without purplish or dark spot or ring on each side of throat; anterior half with many black dots, merging into lengthwise lines and stripes; orbital tentacle longer than eye, fringe-edged; nasal tentacle palmate; dorsal XIII, 15 to 17; anal II, 16 to 18.....

16. *S. aneitensis*.

- f*². Dorsal with 19 or more rays.

*g*¹. Sides with 2 rows of short blue or pearl bars; a circular blue-black spot at upper angle of opercle; a blue bar below, and a blue spot behind eye, blackening in preservative; a small canine below; small simple orbital tentacle; dorsal XII, 20 or 21; anal I or II, 20 or 21.

6. Females of *S. periophthalmus*.

Also with 4 to 8 brown lines from near tip of pectoral to above middle of anal.

S. periophthalmus var. *visayanus*.

*g*². Without blue or pearl bars along sides.

*h*¹. Brown, with 5 to 7 darker lines along sides; no canines; orbital tentacle small, finely fringed; nasal tentacle similar but smaller; dorsal XII, 23 or 24; anal II, 23 or 24.....

8. Females of *S. lineatus*.

*h*². Without longitudinal black lines on sides.

*i*¹. Reddish brown, with conspicuous rows of short blackish-brown bars and spots on sides, a row of spots on lower part of anal; often a blue dot or bar behind eye; simple tentacle on eye and a small divided nasal one; a minute canine below; dorsal XIII, 19 or 20; anal I, 19 or 20.....

17. *S. interruptus*.

*i*². Not as above; no canines.

*j*¹. Dorsal free from caudal; whitish with 7 brown spots on side, each with 3 or more conspicuous black dots; a row of prominent black dots along lower part of side; minute simple tentacles on eye, nape, and nostril; dorsal XII, 19 or 20; anal II, 20.

18. *S. fowleri*.

*j*². Dorsal attached to caudal.

k¹. Pectoral clear, with 3 rows minute brown dots; a row of red-brown spots above anal, and 2 to 4 rows posteriorly; dorsal and caudal clear, with 4 rows red-brown spots; males with a small canine; simple tentacle over eye; nasal tentacle bifid or trifid; dorsal XIII, 19 or 20; anal I, 19 to 21..... 19. *S. deani*.

k². Pectoral not as above.

l¹. Brown with faint darker crossbands and many reddish to dark-brown dots or small spots all over body, dorsal, caudal, and pectorals; orbital and nape tentacles small; nasal tentacle very small, usually composed of 4 filaments; dorsal XIII, 19 to 21; anal I, 20 to 22.

11. Females of *S. edentulus*.

l². Dorsal XII or XIII, 20 to 22; anal I, 23 or 24, or III, 22; 7 double brown crossbars and 2 rows of brown dots on each half posteriorly; dorsal and caudal barred with brown and white, anal brown, all 3 fins white-margined; orbital tentacle equal to, or more than eye, tip and marginal filaments white or very pale.

16. Females of *S. aneitensis*.

1. *SALARIAS FUSCUS* Rüppell.

Salarias fuscus RÜPPELL, Neue Wirb. Fische (1935) 135, pl. 32, fig. 2; FOWLER, Copeia (June 18, 1918) 65; Acad. Nat. Sci. Phila. 79 (1927) 295.

Salarias holomelas GÜNTHER, Ann. & Mag. Nat. Hist. IV 10 (1872) 399; MEYER, An. Soc. Esp. Hist. Nat. Madrid 14 (1885) 31; HERRE, Fishes 1931 Philip. Exped. (1934) 97.

Dorsal 29 to 31; anal 19 or II, 18 or 19.

Body deep, often pot-bellied, much compressed; dorsal profile slanting rapidly downward from dorsal origin to caudal peduncle; anterior profile vertical or nearly so, usually projecting slightly beyond mouth. Depth 2.7 to 2.8, head 3.75 to 4 times in length. Caudal fin slender and elongate in small or medium-sized specimens, 2.5 to 2.8 times in length. Eye large, far forward, conspicuous, 3.75 to 4.25, snout 2.45 to 2.7 times in head. Margin of upper lip fimbriate; no canine teeth. Tentacles on eye and nape small, slender, simple, often difficult to find; nasal tentacles very small, simple or divided. Dorsal not notched, slightly or not at all attached to caudal. Last dorsal and anal rays often much elongated, extending nearly to end of caudal.

Dark brown to black; in the typical form the caudal is yellow, but every gradation occurs from all yellow through partly yellow to entirely black. Pectoral also yellow, with a circular black spot on upper part of base in typical *fuscus*, but it too varies in

color so that some individuals have the pectorals entirely dark brown.

I have examined 4 specimens from Jolo, 44 to 63 mm long, 10 from Sibutu, 47 to 67 mm long; and 12 from Sitankai, 34 to 60 mm long. Previously reported from Cebu. This blenny was first described from the Red Sea, but occurs abundantly as far east as the Pelew and Fiji Islands. I have never seen this blenny leave the water or cavort around on the rocks at low tide; it apparently always remains in the water.

2. *SALARIAS CERAMENSIS* Bleeker.

Salarias ceramensis BLEEKER, Nat. Tijdschr. Ned. Ind. 3 (1852) 701;
HERRE, Fishes Herre 1931 Philip. Exped. (1934) 96.

Dorsal 29 or 30; anal I, 19 or 18. Depth 3.33, head 3.8 to 3.9, caudal 4.3 to 4.4 times in length. Anterior profile of head vertical; a broad palmately fringed tentacle on each side of nape, a narrower one on each eye, and a very small palmately fringed pair of nasal tentacles. No canines. Dorsal not notched, attached to caudal.

Alcoholic specimens brown, thickly sprinkled with blue-black dots; dorsal and caudal both cross-barred with rows of brown spots and with several rows of black dots along upper margin of dorsal and tip of tail. The anal may be sprinkled with dusky spots or clear brown.

Two specimens, 33 and 57 mm long, were examined from Sitankai. A specimen 112 mm long, from Singapore, has the tips of all the anal rays elongated, the anterior rays much elongated and almost entirely free.

A rare species, previously known only from Ceram, Buru, Amboyna, Misol, and Gebé, in the Dutch East Indies.

3. *SALARIAS FASCIATUS* (Bloch).

Blennius fasciatus BLOCH, Ichtyologie 2 (1786) 110, pl. 162, fig. 1.

Salarias fasciatus GÜNTHER, Cat. Fishes 3 (1861) 244; MEYER, An. Soc. Esp. Hist. Nat. Madrid 14 (1885) 31; PETERS, Monatsber. Akad. Wiss. Berlin (1868) 269; JORDAN and SEALE, Proc. U. S. Nat. Mus. 18 (1905) 799; EVERMANN and SEALE, Bull. Bur. Fish. 26 (1907) 104; JORDAN and RICHARDSON, Bull. Bur. Fish. 27 (1908) 284; FOWLER and BEAN, Proc. U. S. Nat. Mus. 62 (1923) 72; FOWLER, Proc. Acad. Nat. Sci. Phila. 79 (1927) 295; HERRE, Journal Pan Pac. Res. Instit. 8 (1933) 11; Fishes Philip. Exped. 1931 (1934) 97.

Dorsal XII, 19 or 20; anal I, 19 or 20. Depth 3.6 to 4, head 4.1 to 4.3 times in length. Eye 3 to 3.4 times in head. A bifid or trifid tentacle over each eye, a small bifid nasal tentacle, and

a broad fringed one on each side of nape. No canines. Undivided dorsal attached to caudal fin; anterior anal rays more or less detached, with elongate tips.

This large, heavy-bodied rock skipper is common in tide pools on rocky coasts, and, as shown by the list of citations above, has been collected many times in Philippine waters. When disturbed, it is one of the first fishes to leave, leaping over obstacles and climbing rocks with great speed; the very large individuals nearly always depart at the first hint of danger, so that they are seldom caught.

In life more or less violet-brown to bluish, with 6 to 8 broad brown bands across dorsal and body; between these bands, especially on lower part of body, on pectoral base, and on head sometimes, are sky-blue circular spots; on upper part of anterior half of body are many blue-black dots which pass into blue-black along middle of body; on dorsal two or three rows of very pale or bluish spots separated by broken upper ends of crossbars.

Alcoholic specimens brown, rarely bluish brown, with 6 to 8 broad darker-brown crossbands which extend on lower half of dorsal fin, breaking up into two bars and then fine lines on upper half. The blue-black dots and lines are as in life. Large yellowish or whitish circular spots, often with a central dark dot, usually covering pectoral base and under surface of body and head, and up to level of pectoral base. Dorsal as in life, but darker; pectoral and caudal pale, cross-banded by several rows of dark-brown or black spots; anal pale to dark brown, with two rows of dark-brown dots, tips of rays usually white.

This blenny, called *palu* at Cagayancillo, is found on all Philippine coasts, and is one of the easiest of our rock skippers to recognize. It is entirely unlike any others, so that it is never confused with the rest of the group. I have examined Philippine specimens ranging from 20 to 106 mm in length, from the following localities: Alabat Island, 1; Bacon, Sorsogon, 1; Bais, Oriental Negros Province, 6; Cabalian, Leyte, 2; Calapan, Mindoro, 2; Cebu, Cebu, 4; Dumaguete, Oriental Negros Province, 12; Iba, Zambales Province, 1; Nasugbu, Batangas Province, 2; Polillo, 1; Punta Flecha, Zamboanga Province, 4; Sibutu, 4; Sitangkai, 18; Southern Negros, 1.

I have also examined the following specimens, ranging from 25 to 125 mm in length: Ishigaki, Riukiu Islands, 1; Taruna, Sangir Island, 3; Singapore, 5; Pelew Islands, 5; Nukulau, Fiji, 4; Ovalau, Fiji, 3; Suva, Fiji, 4; Apia, Samoa, 10. Two of the

Singapore specimens are much larger than any seen from the Philippines. These big specimens are females, the males never reaching much more than 75 mm.

This species ranges throughout Polynesia and westward to the Red Sea and the East Coast of Africa.

4. *SALARIAS NITIDUS* Günther.

Salarias nitidus GÜNTHER, Cat. Fishes 3 (1861) 243; Fische der Südsee 2 (1876) 200, pl. 113, fig. F (Description *pro parte*; not fig. G, which is *S. belemnites*); HERRE, Fishes Herre 1931 Philip. Exped. (1934) 97.

Salarias alboguttatus HERRE, Fishes Herre 1931 Philip. Exped. (1934) 96 (not of Kner).

Dorsal XII or XIII, 18 or 19 to 22; anal II, 20 to 22 or I, 23. Depth 6.9 to 7.3, head 5 to 5.3 times in length. Minute simple orbital and nasal tentacles, and a pair of similar tentacles on nape. Very small canines in lower jaw, but these may be absent. Dorsal free from caudal.

Alcoholic specimens gray to grayish brown, with 7 broad brown crossbands on upper two-thirds of body and extending on dorsal fin; sides of head sprinkled with pearly white spots, 2 or 3 rows of elongate brown-edged white spots on sides of body. Dorsal more or less reddish brown, spotted where crossed by dark bands extending up from trunk, and with 3 or 4 rows of white spots; anal clear, with a submarginal row of white spots and a dark-brown margin; caudal with cross rows of white spots, and a few dark specks, with dark-brown margins.

I have examined 17 specimens from Dumaguete, Oriental Negros Province, 22 to 37 mm long.

Salarias alboguttatus Kner, which resembles the above species very much, differs by having a large violet or violet-brown spot on each side of the throat.

Salarias nitidus is only known positively from the China Sea and the Philippines. The fish reported from Samoa as *S. nitidus* by Günther is *Salarias belemnites* deVis., which is widespread in Polynesia.

5. *SALARIAS COLEI* Herre.

Salarias colei HERRE, Fishes Herre 1931 Philip. Exped. (1934) 96.

Dorsal XV, 19; anal II, 20.

Depth 5.2 to 5.25, head 4.25 to 4.35, caudal 5 or 4.5 times in length. Eye 3.66 to 3.9, snout 2.6, least depth of caudal peduncle 2.3 times in head.

Body elongate, compressed; breadth of head equal to its depth; maxillary extending beneath hind margin of eye. On eye a stout, flat, marginally fimbriate tentacle, its length two-thirds that of eye; a fringed tentacle on anterior nostril; on nape a rounded crest. Dorsal deeply notched, free from caudal.

Alcoholic specimens uniform light brown, with 8 broad dark-brown crossbars, which divide below middle of side, and a dark crossband at caudal base. Sides of head sprinkled with many small, brown spots, or almost uniform in color. Dorsal mottled, or streaked with dusky lines running diagonally upward and backward; anal uniformly dusky, dorsal and anal rays tipped with white; caudal light brown to clear.

The type, 57 mm long, and one paratype, 50 mm long, are from Culion. No other specimens have been collected.

6. *SALARIAS PERIOPHTHALMUS* Cuvier and Valenciennes.

Salarias periophthalmus CUVIER and VALENCIENNES, Hist. Nat. Poiss.

11 (1836) 311, pl. 328; PETERS, Monatsber. Akad. Wiss. Berlin (1868) 269; HERRE, Journ. Pan Pac. Res. Inst. 8 (1933) 11; Fishes Herre Philip. Exped. 1931 (1934) 97.

Salarias deani JORDAN and SEALE, Bull. Bur. Fish. 27 (1908) 284.

Dorsal XII, 20 or 21; anal I or II, 20 or 21.

Very elongate, slender, strongly compressed. Depth 5 to 5.4, head 4.4 to 4.6, caudal 4.25 to 4.8, and pectoral 6 times in length. Eye 4, snout 3.1, least depth of caudal peduncle 2.25 times in head. Mouth inferior, convex profile bulging opposite eyes which are very far forward, maxillary extending well behind eye. Both sexes with a small curved canine on each side of lower jaw. Females with a small simple orbital tentacle; males with a longer one, equal to or more than eye, and a low median crest on top of head.

In life roseate, with 5 to 7 violet or violet-brown wide cross-bars, which are violet-red and divided on lower part of body; along sides two rows of widely spaced short pearly blue bars which form a highly characteristic feature of this easily recognized species. Males with a pearly blue circular spot on opercle. Females with one or two pearly blue spots behind eye and a similar short bar below it. Sometimes males with blue spots behind eye.

Alcoholic specimens mottled leaden and brown or very dark brown, crossbands often dim or disappearing. Pearly blue bars and spots may retain their color, but more often blacken and sometimes disappear; careful examination will reveal some or

all of them, even when they seem to be absent; they are usually margined with black. Dorsal brown, with a white margin, and several darker lines or rows of spots running upward and backward; anal brown, with a dusky marginal band; caudal brown, its upper margin white, its basal portion with cross rows of white dots, and longitudinal white lines on membranes; tip may be white.

This is one of the most agile of the rock skippers, as well as one of the easiest to recognize. The coloration of preserved specimens is subject to very great variation, but the rows of pearly blue bars will always ensure identification. Females reach a length of 150 mm, but I have been unable to capture any such large and exceedingly active specimens.

I have examined the following Philippine specimens: Fifty-four from Nasugbu, Batangas Province, 22 to 51 mm long; 44 from Dumaguete, Oriental Negros Province, 15 to 38 mm long; 3 from Currimao, Ilocos Norte Province, 45 to 66 mm long; 9 from Culion, 36 to 55 mm long; 1 from Punta Flecha, Zamboanga Province, 34 mm long; 1 from Calayan, 60 mm long. The specimen from Calayan (?) *Salarias deani* Jordan and Seale in the citation above, is a male of *S. periophthalmus*.

The Stanford Museum also contains a specimen, 60 mm long, from Nukulau, Fiji; 4 specimens, 28 to 88 mm long, from Apia, Samoa; 12 specimens, 16 to 42 mm long, from Wala Island, New Hebrides; 1 specimen, 45 mm long, from Waigiui; and 1 specimen, 90 mm long, from Durban, Natal, South Africa.

SALARIAS PERIOPHTHALMUS var. VISAYANUS Herre.

Salarias periophthalmus var. *visayanus* HERRE, Fishes of the Herre 1931 Philip. Exped. (1934) 97, 98.

This well-marked variety is distinguished at once from the typical form by the presence of 4 to 8 longitudinal brown lines along each side; these lines are of variable length and irregular course, but usually extend from near the tip of the pectoral to above the middle of the anal. In alcohol they often partially disappear, and sometimes seem to vanish altogether.

The body and head are as in the typical form. In alcohol the lower half of the dorsal is pale to whitish brown, the upper half darker brown, with a conspicuous white margin; on all but the anterior part the dorsal is marked by widely spaced dark-brown lines running upward and backward. The caudal is cross-barred by white dots, its tip broadly white or whitish.

Abundant at Dumaguete, Oriental Negros Province, and at Culion, and no doubt all through the central and southern Philip-

pinos. The type is 66 mm long, and 17 paratypes from Dumaguete, Oriental Negros Province, and 15 paratypes from Culion range down to a length of 20 mm. I also collected 4 specimens at Mombasa, East Africa, 34 to 64 mm long.

7. *SALARIAS CAUDOLINEATUS* Günther.

Salarias caudolineatus GÜNTHER, Fische der Südsee 2 (1876) 209, pl. 116, fig. F; HERRE, Journ. Pan Pac. Res. Inst. 8 (1933) 11; Fishes Herre Philip. Exped. 1931 (1934) 96.

Dorsal XIII, 20 to 23; anal I or II, 20 to 24.

Body elongate and compressed, depth 5 to 5.7, head 4 to 4.9, caudal 4.6 to 5 times in length. Eye 3.4 to 3.8, snout 2.8 to 3 times in head. Dorsal deeply notched, very slightly attached to caudal. Males usually with a large to very large median crest, but this is a highly variable character. Some specimens 25 to 30 mm long have an extravagantly large crest, while some males of 50 mm have a crest that is little more than a slight ridge. Females apparently lack the crest, though some individuals that seem to be females have a very small one. The mouth parts of many specimens from the Philippines, Polynesia, and the east coast of Africa show no canines in the lower jaw, except in 9 specimens, 16 to 50 mm long, which I collected at Hog Harbor, Espiritu Santo Island, in the New Hebrides. Günther and Fowler both state canines are present but they are evidently rarely developed. The orbital tentacle is variable with sex and age. It is often slender, pointed, and shorter than the eye, but may be much longer; males often have it with fibrillose margins, and it may become broad with long marginal fibrils. Upper lip crenulate.

Alcoholic specimens vary from pale gray or almost white to reddish brown or brown, with 6 to 8 broad darker-brown double crossbars over the back and down the sides; often these are reduced to dark-brown or blackish spots or bars beneath the dorsal and on its basal portion. On each side of the body are from 5 to 7 longitudinal black or very dark-brown lines, which break up posteriorly into dashes and dots. The dorsal is white or colorless, with black or brown dots or bars or with blackish lines running upward or backward, or the hind half may have 5 to 8 fine, wavy, longitudinal, reddish-brown lines. The anal is white or pale, with a basal row of dark-brown dots, or whitish with a submarginal dusky band and white tips on the pointed rays in females, or in males the entire outer portion, including the tips of the rays, may be black or blackish. The caudal is barred by numerous rows of black dots, the tip pale or whitish.

I have examined Philippine specimens as follows: One from Calapan, Mindoro, 40 mm; 33 from Nasugbu, Batangas Province, 15 to 61 mm; 22 from Dumaguete, Oriental Negros Province, 21 to 67 mm; and 1 from the South Coast of Cotabato Province, Mindanao, 65 mm long. In addition, I collected 3 specimens, 37 to 53 mm long, at Mombasa, East Africa; 2 at Waigiu, 43 to 48 mm long; a female, distended with eggs, at Malo Island, New Hebrides, 53 mm long; 1, 39 mm long, from Vila, Efate Island, New Hebrides; 10, from 40 to 86 mm long, from Wala Island, New Hebrides; and 2, from 52 to 72 mm long, from Ovalau, Fiji. This handsome rock skipper occurs all over the Indo-Pacific region.

8. *SALARIAS LINEATUS* Cuvier and Valenciennes.

Salarias lineatus CUVIER and VALENCIENNES, Hist. Nat. Poiss. 11 (1836) 314; HERRE, Journ. Pan Pac. Res. Inst. 8 (1933) 11; Fishes Herre Philip. Exped. 1931 (1934) 97.

Dorsal XII, 23 or 24; anal II, 23 or 24. Depth 5 to 5.3, head 4.5 to 4.9, caudal 5.65 to 5.5 times in length. Eye 3.8, snout 2.9 times in head. Body slender, elongate, compressed; anterior profile of broadly convex head nearly vertical. A small, finely fringed orbital tentacle and a smaller one on the anterior nostril. No canines; dorsal fin deeply notched. Males have a low median crest on head, which is lacking in females.

Alcoholic specimens vary from grayish brown and reddish or purplish brown to leaden, with 6 short black or dark-brown double crossbars over back; alternating with these are 6 pairs of dark-brown double bars on lower two-thirds of body. Along each side, from head to caudal base, 4 to 6 black lines, some of which may be wavy and run together, or may not extend all the way. Dorsal varying from clear or whitish to pale brown, with 4 to 8 dark-brown lines running upward and backward, those along top of second dorsal nearly horizontal and very close together, leaving a whitish band along middle of second dorsal. Anal very pale to light brown, with a dark-brown or blackish margin. Caudal whitish basally with remainder purplish brown, or entirely pale to dark brown. Philippine specimens have blackish vertical lines on snout and sides of head.

Five excellent examples, 40 to 77 mm long, were obtained at Dumaguete, Oriental Negros Province, and 3, 49 to 62 mm long, in wretched condition, were received from Nasugbu, Batangas Province. In addition I have examined the following: 2 from

the Sembilan Islands, on the west coast of the Malay Peninsula, 109 and 112 mm long; 1 from Lembah Strait, Celebes, 48 mm long; 2 from Ovalau, Fiji, 29 and 52 mm long; and 3 from Pago Pago, Samoa, 58 to 85 mm long. This species is found from the Andaman Islands eastward throughout Polynesia.

9. *SALARIAS OORTI* Bleeker.

Salarias oorti BLEEKER, Nat. Tijds. Ned. Ind. 1 (1850) 257, fig. 15; HERRE, Journ. Pan Pac. Res. Inst. 8 (1933) 11; Fishes Herre Philip. Exped. 1931 (1934) 97.

Dorsal XIII, 19 to 21; anal I or II, 19 or 20, or I, 21 or 22; depth 5.3 to 5.8, head 4.65 to 4.8, caudal 4.45 to 4.7 times in length; eye 3.75 to 3.9, snout 3 to 3.2 times in head. Interorbital space concave, eyes very far forward, anterior profile vertical or forehead projecting beyond mouth; maxillary extending beneath hind margin of eye; my specimens have no canines, but Bleeker and Günther state that adults have small canines in the lower jaw. A rather large rounded median crest on top of head; orbital tentacle two-thirds as long as eye and simple, or very small and simple, or small and fringed.

Roseate, with many violet crossbands, often arranged in pairs, and broader than interspaces, but breaking up into irregular lines on last third of body. First part of dorsal violet or reddish, with four diagonal or longitudinal wavy blue stripes; hind part violet or rose, with or without a broad yellow or pale band along middle, and 5 or 6 diagonally lengthwise dark-edged blue stripes on upper half. Anal darker than body, caudal paler, with outer third reticulated with blue lines enclosing white spots. Alcoholic specimens roseate and violet, turning to violet-brown and brown, and blue lines on fins becoming dark brown.

A specimen, 68 mm long, from Atimonan, Tayabas Province; 1, 56 mm long, from Calapan, Mindoro; 2, 56 mm long, from Dumaguete, Oriental Negros Province; 1, 58 mm long, from Iba, Zambales Province; and 1, 71 mm long, from Mariveles, Bataan Province, have been examined. This handsome rock skipper is known elsewhere from Sumatra, Java, and the Moluccas, and has also been reported from Fiji and Zanzibar.

10. *SALARIAS BILINEATUS* Peters.

Salarias bilineatus PETERS, Monatsber. Akad. Wiss. Berlin (1868) 269; HERRE, Fishes Philip. Exped. 1931 (1934) 96 (in part; Culiön specimens only).

Dorsal XII, 15 to 17, or XIII, 17 or 18; anal I or II, 16 to 18. Depth 5, head 3.9 to 4, rounded caudal 4 to 4.6 times in length.

Eye 4 to 4.5, snout about 3 times in head. Anterior profile of head rounded, projecting, eyes very high up and projecting above dorsal profile.

Males with a median crest on head, a small orbital tentacle, simple or with fringed margins, a minute one on nape, and a minute fringed nasal tentacle. There may be a minute canine on each side of lower jaws. Females have no crest, a simple or fringed tentacle on eye only, and no canines.

Alcoholic specimens gray, densely punctate with brown, or fading to uniform slate, with 6 double dark-brown crossbands; on sides between dark bands two rows of white dots, or numerous white dots arranged in backward curving vertical rows, with 4 to 6 dots in a row, with smaller blue dots on sides of head. All dots may become brown in preserved specimens. Three dark bands on snout and lower part of preopercle and extending on throat, with white bands or spots between them on throat; behind eye a black bar. Dorsal clear, with a characteristic black spot at top between first and second spines; about 9 blackish bars running up and back on second half of dorsal. Anal clear or with a dark submarginal band; caudal with a blackish spot at its base.

Specimens were examined as follows: Seven from Culion, 30 to 45 mm long; 4 from Nasugbu, Batangas Province, 25 to 27 mm long. Peters had a single specimen, taken on a coral reef east of Lauang, Samar. This rock skipper seems to be confined to the Philippines.

The three specimens from Nasugbu placed under *S. bilineatus* in Fishes of the Herre 1931 Philippine Expedition (1934) 96, are really *Salarias frenatus*.

11. *SALARIAS EDENTULUS* (Bloch & Schneider).

Blennius edentulus BLOCH & SCHNEIDER, Syst. Ich. (1801) 172.

Salarias edentulus GÜNTHER, Fische der Südsee 2 (1877) 206, pl. 117, fig. A, showing the female; JORDAN and SEALE, Proc. U. S. Nat. Mus. 28 (1905) 789; JORDAN and RICHARDSON, Bull. Bur. Fish. 27 (1908) 284; HERRE, Journ. Pan Pac. Res. Inst. 8 (1933) 11; Fishes Philip. Exped. 1931 (1934) 97.

Salarias rivulatus JORDAN and RICHARDSON, Bull. Bur. Fish. 27 (1908) 284.

Salarias quadricornis GÜNTHER, Fische der Südsee 2 (1877) 209, pl. 117, fig. B, showing the male of *S. edentulus*.

Dorsal XIII (rarely XIV) 19 to 21; anal usually I (rarely II), with 20 to 22 rays, exceptionally 23 or 24. A female 65 mm long has the depth 3.1, the head 4 times in the length. Eye 3.7,

snout 2.35 times in head. A female 84 mm long, ready to spawn, has the depth equal to the head, 4 times in the length. Eye 4, snout 2.66 times in head. In males 75 to 78 mm long, depth equal to head, 4.3 to 4.7 times in length. Eye 3.8 to nearly 4, snout 2.3 times in head.

Both sexes have a simple orbital tentacle, shorter than the eye, and a pair of small simple tentacles on the nape; one or both of these last are often absent; the front nostril has a very small tentacle which is usually divided into 4 filaments. The high dorsal fin is deeply divided and is broadly united with the caudal fin. The anterior anal rays have more or less elongate and swollen tips.

The sexes are unlike and have been described as different species. *S. edentulus* of many authors is the female, and *S. quadricornis* is the male. An important male character is the presence of a high median occipital crest; but at Makatea Island, one of the Tuamotu Archipelago, I secured females varying from those with the typical smooth occiput to some with a moderately high crest.

Typical females are like Günther's figure, cited above. In alcohol the brown body is faintly cross-barred by darker bands, and thickly strewn with many reddish to dark-brown spots. The dorsal, caudal, and pectorals are covered with smaller similar spots. Anal with 2 or 3 rows of dark-brown spots, rays with white tips.

Males darker, becoming uniform dark brown, or brown with darker crossbars, or black with pale or whitish crossbars or narrow whitish cross lines. The anal has two lengthwise rows or lines of bluish spots, which often disappear in alcohol; tips of rays white. The forward half of the dorsal has longitudinal, the second half diagonal, rows of pale-yellowish or whitish spots and lines, which usually disappear in alcohol. There is a diagonal dark bar behind the eye, which often disappears.

This is by far the commonest of all Philippine blennies. Preserved specimens are subject to great variation in color, and often all markings entirely disappear. Examination of a large series will enable one to place such puzzling specimens. The following Philippine specimens were studied, their lengths varying from 16 to 106 mm: Cabalian, Leyte, 1; Calapan, Mindoro, 2; Calayan Island, 4; South Coast of Cotabato Province, 1; Dumaguete, Oriental Negros Province, 81; Guindulman, Bohol Province, 1; Iba, Zambales Province, 1; Jolo, Sulu Province, 1;

Kolambugan, Lanao Province, 1; Nasugbu, Batangas Province, 46; Odiongan, Tablas, 4; Sitankai, 2.

I have also examined specimens as follows: Hoihow, Hainan Island, 1 specimen, 51 mm long; Pu Taw Island, Chusan Archipelago, China, 2, each 42 mm long; Pelew Islands, 3 specimens, 32 to 55 mm long; Tinian Island, Marianas, 2 specimens, 60 and 75 mm; Lembbeh Strait, Celebes, 6, from 40 to 67 mm; Waigui, 3, from 47 to 61 mm long; Lord Howe Island, 2 very fine specimens, 61 and 101 mm long; from the New Hebrides, 25 at Wala Island, 25 to 63 mm long; 4 at Malo Island, 40 to 51 mm long; and 72 at Hog Harbor, Espiritu Santo Island, 13 to 80 mm long; from Ovalau Island, Fiji, 4, from 30 to 58 mm long; 13 from Pago Pago, Samoa, 23 to 77 mm long, 46 elegant specimens from Makatea, Tuamotu Archipelago, 33 to 104 mm long; from the Marquesas Islands, 54 taken at Atuona, Hiva Oa Island, from 26 to 78 mm long, and 38 from Nuka Hiva Island, 13 to 84 mm long. I also collected a specimen 45 mm long at Mombasa, East Africa.

12. *SALARIAS ZAMBOANGÆ* Evermann and Seale.

Salarias zamboangæ EVERMANN and SEALE, Proc. U. S. Nat. Mus. 31 (1907) 512, fig. 4; HERRE, Journ. Pan Pac. Res. Inst. 8 (1933) 11; Fishes 1931 Philip. Exped. (1934) 98.

Dorsal XII or XIII, 20 to 22; anal I, 23 or 24, or II, 21 to 24, or III, 22.

Caudal fin equal to depth, 4.75 to 5.25 times in length, head 4.2 to 4.5 times. Eye 4.25 to 4.3, snout 3 times in head.

Body slender, compressed, head rounded, with vertical anterior profile, eyes prominent, projecting upward and outward. Males with a medium-sized to large crest on midline of head; orbital tentacle usually with a white tip and white-tipped marginal filaments, equal to or longer than eye; nasal tentacle small, bifid or trifid; no tentacles on nape, no canines in lower jaw. Females without skinny crest on head. Dorsal fin of moderate height, not very deeply incised, attached to caudal, its last rays projecting to middle of caudal when depressed.

Alcoholic specimens whitish or bluish-brown to light brown, with 7 brown double crossbars over back and down sides, and usually two rows of small, round, brown spots or dots on lower part of posterior part of body. First dorsal marked by wavy longitudinal or downward curving dark lines, often with a blackish spot at top between first and second and second and third spines; posterior part marked by several diagonal rows

of dark spots, often with a clear band along middle; there may be a dark submarginal band, made up of fine dark lines; dorsal, caudal, and anal all white-margined. Anal with a dusky submarginal band, rest of fin colorless to brown; caudal barred by several rows of dark-brown spots.

Specimens have been examined as follows: Five from Nasugbu, Batangas Province, 38 to 54 mm long; 3 from Calapan, Mindoro, 44 to 47 mm long; 2 specimens from Bais, Oriental Negros Province, 53 mm long; 39 from Dumaguete, Oriental Negros Province, 23 to 63 mm long; a female specimen, from Lembeh Strait, Celebes, 57 mm long. Originally described from 3 specimens, 51 to 69 mm long, taken at Zamboanga Province.

15. *SALARIAS FRENATUS* Cuvier and Valenciennes.

Salarias frenatus CUVIER and VALENCIENNES, Hist. Nat. Poiss. 11 (1836) 342; GÜNTHER, Cat. Fishes 3 (1861) 246; DAY, Fishes of India (1878-1888) 335, pl. 70, fig. 9; SAUVAGE, Poissons de Madagascar (1891) 388, pl. 41A, fig. 5.

Salarias bilineatus HERRE, Fishes 1931 Philip. Exped. (1934) 96, *pro parte*; 3 specimens from Nasugbu.

Dorsal XII or XIII, 15 to 17; anal I, 17 to 19 or II, 16 or 17.

Depth 5.1 to 5.2, head 4.4 to 4.6, caudal 4.25 to 4.4 times in length; eye prominent, 3.9 to 4, vertical snout 2.5 to 2.75 times in head. Orbital tentacle broad, pointed, equal to eye, with fimbriate edges; no tentacle at nape and a very small simple tentacle on nostril. Largest specimens with a slight suggestion of a nuchal crest. Upper lip denticulated. Some specimens, most likely males, have a very small canine in the lower jaw. Dorsal deeply incised, free from caudal, anterior portion lower than rear half.

Alcoholic specimens varying from slate-blue, crossed by 8 or 10 darker-blue bands, to bluish or brownish-gray with brown or bluish-brown crossbands; dark lines from eye over snout, preopercle, opercle, and across under side of head. In life pearly blue or white bands with dark margins on head; these bands fading to brown like rest of head, leaving their margins as dark lines mentioned above. First dorsal clear to dusky, often with a blackish spot at top between first and second spines, second dorsal with diagonal dark-brown bands; caudal clear to dusky, or with cross rows of brown spots; anal clear, or with a submarginal row of brown spots on membranes; pectoral clear above, brown on lower half.

Thirty-two specimens, 22 to 62 mm long, were taken at Nasugbu, Batangas Province. My specimens agree in all essentials with Day's and Sauvage's figures. The original description erred in saying the dorsal is not divided. Day's figure was made from one of the types, and, as he states, the second dorsal is "separated by a well marked notch." Both Day and Sauvage have improved on the original description, but Sauvage is the only one who mentions the crenulated upper lip.

Salarias crenulatus M. Weber is very close to *S. frenatus*, but I cannot make my specimens agree with either Weber's description or figure. Originally described from India, and later from Madagascar, this blenny is reported for the first time from the Philippines. I do not doubt its occurrence in many other localities over a large part of the Philippines, but it has been overlooked by collectors.

14. SALARIAS MARMORATUS (Bennett).

Blennius marmoratus BENNETT, Zool. Journ. 4 (1828) 35.

Salarias marmoratus CUVIER and VALENCIENNES, Hist. Nat. Poiss. 11 (1836) 305; HERRE, Fishes 1931 Philip. Exped. (1934) 97.

Dorsal XII or XIII, 14 to 16; anal I or II, 16 or 17.

Depth 4.8 to 5.2, head 3.8 to 4.3 times in length; broad, somewhat obliquely truncate caudal equal to head. Eye 3.5 to 4.2, snout 2.4 to 2.6 times in head.

Head broad, with rounded profile and nearly vertical snout; eyes projecting, very high up and far forward; orbital tentacle marginally fringed and equal to, or nearly equal to, eye; a pair of very small simple tentacles at nape; nasal tentacles very short, broad, palmately fringed. Upper lip rather coarsely crenulate.

Alcoholic specimens pale tan to purplish brown, often gray or white on upper side, with 5 or 6 dark-brown double cross-bands on sides, alternating with an equal number of short dark-brown double bars on back; lateral bars may break down into spots which often are clustered along the middle of the side; a blackish-brown elongate vertical bar or black spot behind eye, a blackish blotch above pectoral base. Head often thickly sprinkled with white or bluish dots, spotted and mottled anteriorly and underneath with pearly or bluish. Fins pale, dorsal and caudal heavily marked with crossrows of brown to black spots; anal with a submarginal dusky band, tips of rays pale or white.

I collected 8 specimens, 29 to 38 mm long, at Nasugbu, Batangas Province, and 3, 27 to 48 mm long, at Dumaguete, Oriental

Negros Province. Specimens were also obtained elsewhere, as follows: Waigiu, 1 specimen, 27 mm long; 3 from Nuka Hiva, Marquesas Islands, 36 to 56 mm long. I also examined 14 fine typical specimens from the Hawaiian Islands, from 50 to 88 mm long.

15. *SALARIAS GUTTATUS* Cuvier and Valenciennes.

Salarias guttatus CUVIER and VALENCIENNES, Hist Nat. Poiss. 11 (1836) 228; HERRE, Fishes Crane Pacif. Exped. Zool. Ser. Field Mus. Nat. Hist. 21 (1936) 409.

Salarias undecimalis JORDAN and SEALE, Proc. U. S. Nat. Mus. 28 (1905) 800, fig. 18; HERRE, Fishes 1931 Philip. Exped. (1934) 98.

Dorsal XI or XII, 17 or 18; anal I, 18 or 19.

Body moderately slender, laterally compressed on posterior half, anterior profile vertical; eyes very prominent, very high up and far forward, projecting beyond contour. Depth 4.4 to 4.8, head 4 to 4.1, caudal 4.1 to 4.5 times in length. Eye 3 to 3.2, snout 2.85 to 3 times in head.

Low dorsal deeply divided, not attached to caudal fin. Small simple tentacles present on eye, nape, and nostril. Head without crest, lower jaw without canines.

Alcoholic specimen varying from pale brown to reddish brown, with 6 or 7 pale or white double crossbands on sides of body, which are forked on the lower half of trunk; very often they break up into white dots on upper part; between them body color appears as an equal number of darker bands. On the upper half of body numerous short vertical violet to violet-black lines and dots, especially on forward half; usually a row of 15 to 20 black dots just below dorsal fin, often another row of larger black dots extending from above pectoral to caudal base, or black dots sprinkled sparingly on side. On lower end of pectoral base and just in front of it one or two large circular white or very pale-brown spots are very characteristic. Sides of head, pectoral base, and lower half of trunk more or less white-spotted. On each side of throat a dark purplish spot or ring. Dorsal and caudal colorless, cross-barred by rows of brown spots on rays; anal more or less dusky marginally, tips of rays much paler.

I have collected and examined the following: 2 from Nasugbu, Batangas Province, 24 and 35 mm long; 4 from Culion, 29 to 39 mm long; 19 from Bais, Oriental Negros Province, 22 to 35 mm long; 6 from Dumaguete, Oriental Negros Province, 25 to 34 mm long; 6 from Punta Flecha, Zamboanga Province, 21 to 32 mm long; and 13 from Sitankai, 29 to 48 mm long.

The Stanford Museum also contains two cotypes of *Salaria undecimalis*, 30 and 37 mm long, collected by Dr. Bashford Dean at Bais, Oriental Negros Province. Most of the specimens above were determined as *S. undecimalis*, but are unquestionably *Salaria guttatus*. They agree with typical specimens of *S. guttatus* which I collected in the New Hebrides. Two faded specimens from Singapore, 40 and 62 mm long, also belong here.

For many years this handsome rock skipper was known only from two small specimens collected at Vanikolo. It is now known from Singapore to Samoa, but is apparently rare everywhere except in the Philippines.

The three sets of simple tentacles, the number of fin rays, and the presence of the pale spots at the pectoral base, the purple spots on the throat, and the black dots along the body separate it from our other rock skippers. The figure given by Jordan and Seale is excellent.

16. *SALARIAS ANEITENSIS* Günther.

Salaria aneitensis GÜNTHER, Fische der Südsee 2 (1877) 205, pl. 118, fig. A.

Dorsal XIII, 15 to 17; anal II, 16 to 18.

Depth equal to head, 4.2 to 4.4 times in length. Rounded caudal shorter than head, 4.6 times in length. Eye 5.6, snout 2.33 times in head.

Robust, broad anteriorly, posterior two-thirds laterally compressed; snout rounded, anterior profile steep but not vertical, eyes not projecting or conspicuous. Orbital tentacle large, pointed, marginally fringed, a trifle longer than an eye diameter; on each side of nape a tiny tentacle, on nostril a short, broad, palmately fringed tentacle. A small canine on either side of lower jaw. Low dorsal deeply incised, free from caudal fin.

Alcoholic specimens dark-reddish-plum-colored, becoming paler to yellowish underneath, back and sides covered with many black dots which pass into lengthwise brown or black stripes on posterior half. Dorsal, caudal, and pectoral with crossrows of dark-brown spots on rays; on dorsal these forming wavy lines running upward and backward. Anal with two black longitudinal stripes, tips of rays pale or white.

Two fine examples, 88 and 117 mm long, were caught at Puerto Galera, Mindoro. They agree with Günther's figure in proportions and markings; as his description was made from a dried specimen the tentacles were not observed.

One of the largest rock skippers, reaching a length of more than 175 mm. It has hitherto been known only from Aneiteum, one of the New Hebrides, Apia, Samoa, and Niuafoou Island.

17. *SALARIAS INTERRUPTUS* Bleeker.

Salarias interruptus BLEEKER, Nat. Tijds. Ned. Ind. 3 (1857) 68.

Dorsal XIII, 19 or 20; anal I, 19 or 20.

In adults depth and caudal approximately equal, 5 to 5.6, head 4.2 to 4.5 times in length; in young specimens depth 6.5 to 6.75 times in standard length; eye 4 to 4.3 times, snout 3.5 times in head. Eyes very high up and far forward, interorbital concave; anterior profile vertical or forehead slightly projecting. A small, simple, orbital tentacle, and a small bifid or trifid nasal tentacle. No crest on head. A minute canine on each side of lower jaw. Dorsal deeply notched, not attached to caudal.

Alcoholic specimens warm reddish brown, with several rows of conspicuous short blackish-brown or black longitudinal bars and spots; dorsal and caudal clear, with 3 rows of black spots on forward part and 4 or 5 rows on hind portion of dorsal, and 5 or 6 crossrows on caudal. Anal with a row of black spots on lower part between rays, a broad submarginal dusky band, and a white margin. Large specimens have a blue dot or short bar behind the eye, and sometimes one below the eye.

Forty-eight examples from Nasugbu, Batangas Province, are 18 to 50 mm long, and 3 from Dumaguete, Oriental Negros Province, are 31 to 59 mm long.

This very handsome rock skipper is found in the East Indies and is said to occur as far eastward as Samoa.

18. *SALARIAS FOWLERI* Herre.

Salarias fowleri HERRE, Philip. Journ. Sci. 59 (1936) 364, pl. 2, fig. 7.

Dorsal XII, 19 or 20; anal II, 20. Minute simple nasal, orbital, and nape tentacles present, or any one or two pairs may be absent; no occipital crest, and no canines.

Depth 6 to 6.2, head 4.8 to 5.1, pectoral 4 to 4.4, ventral 7.75 to 8 times in length. Eye, snout, and least depth of caudal peduncle each 3 times in head. Body elongate, compressed, with bluntly rounded head, which is broader than deep; anterior profile nearly vertical, mouth slightly projecting, maxillary extending beneath posterior portion of prominent eye. Dorsal moderately notched, height 2, that of anal 3 times in head. Dorsal and anal free, not extending to caudal.

Alcoholic specimens whitish, with seven brown spots along middle of side, each spot containing three or more conspicuous black dots; between spots are dots and specks, and along lower side a row of prominent black dots; rather faint brown dorsal bands composed of minute dots opposite lateral spots; head and upper anterior half more or less covered with minute brown specks. Three or four rows of black dots on dorsal rays, intervening portions white, membrane clear; nine or ten black dots beneath anal, which is clear with a black submarginal band and a white margin; caudal with four crossbars.

Described from the type, 31 mm long, and 9 paratypes, 16 to 28 mm long, taken from a tide pool at Dumaguete, Oriental Negros Province. On my last visit to Dumaguete another specimen, 27 mm long, was taken.

Named for Henry W. Fowler, who has made large contributions to our knowledge of Philippine fishes.

19. *SALARIAS DEANI* Jordan and Seale.

Salarias deani JORDAN and SEALE, Proc. U. S. Nat. Mus. 28 (1905) 799, fig. 17; HERRE, Fishes 1931 Philip. Exped. (1934) 97.

Dorsal XIII, 19 or 20; anal I, 19 to 21.

Body elongate, depth varying with age, feeding, and sex; in most specimens from 49 to 56 mm long depth 5.3 to 5.6, but a specimen 46 mm long and stuffed with food has the depth 6 times or more in the length; others about the same length have the depth 6 times in length. Eye large, high up and far forward, $3\frac{2}{3}$ to 3.8, snout 2.7 to 2.9 times in head. Dorsal deeply divided, not attached to caudal fin. Orbital tentacle shorter than eye, usually pointed and slender, but may be broader with fimbriate margins; nasal tentacle bifid or trifid; no tentacles on nape and no crest on top of head. Anterior profile of head vertical or overhanging, angle of mouth behind eye.

Alcoholic specimens light brown, with 6 or more less evident dark-brown double crossbars; these often fading entirely, leaving only a row of red-brown spots above anal and two to four rows of reddish-brown spots on posterior fourth or fifth of body. Dorsal and caudal clear, with three or four rows of red-brown or very dark-brown spots on dorsal rays, and 4 or 5 crossrows on caudal. Anal pale brown, with a large brown spot on lower part of every other ray on last half of fin, and a more or less evident submarginal dark band; tips of rays white. Pectoral colorless, with 3 crossrows of brown dots, or sometimes of brown spots.

This species was described from a specimen obtained at Bais, Oriental Negros Province, by Dr. Bashford Dean. The Stanford Museum contains two specimens, 49 and 57 mm long, collected with the type by Doctor Dean. In addition I have collected and examined 5 specimens from Nasugbu, Batangas Province, 42 to 49 mm long; 8 from Dumaguete, Oriental Negros Province, 19 to 46 mm long; 4 from Opon, Mactan Island, 35 to 56 mm long; 2 from Jolo, 48 and 57 mm long; and 1 from Sitankai, 53 mm long.

Genus **LEMBEICHTHYS** Herre

Lembeichthys HERRE, Philip. Journ. Sci. 59 (1936) 283.

Dorsal 68 to 70; anal 50 to 55.

Body elongate, tapering, naked, with caudal separate from dorsal and anal; dorsal composed of flexible spines, its origin over opercle; origin of anal in anterior portion of body, length of anal more than twice that of head and trunk together; ventrals very small, composed of two rays, inserted beneath hind margin of opercle, distinctly in advance of pectoral. Head deeper and broader than body, without tentacles or barbels, snout blunt, mouth inferior; teeth in one row, fixed, different in the two jaws, those of the lower jaw with arrowlike tips; a large pair of posterior canines in lower jaw, as in *Petroscirtes*. Gill opening small, above upper angle of pectoral base.

Type species, *Lembeichthys celebesensis* Herre.

From *Pholidichthys* Bleeker, to which it is closely related, *Lembeichthys* differs in the dentition, and in having the caudal fin entirely free from the other fins.

LEMBEICHTHYS CELEBESENSIS Herre. Plate 5.

Lembeichthys celebesensis HERRE, Philip. Journ. Sci. 59 (1936) 283, pl. 1, fig. 3.

Dorsal 68 to 70; anal 50 to 55; caudal with 11 rays plus 2 accessory rays on both upper and lower margins.

Depth 15.7, head 7.85 to 8.46, caudal 11, pectoral 12.2 to 12.5 times in length; head and trunk together 2.4 to 2.9 times in tail, which is 70 to 74.5 per cent of the total.

Head broader and deeper than trunk or tail, with a broad, blunt, projecting snout; eye 3.33 to 3.6, snout 4.1 to 5.4 times in head; interorbital equal to eye; mouth inferior and rather large, extending beneath anterior portion of pupil; 20 or 22 flat incisorlike teeth in upper jaw, end tooth on each side pointed

and a little larger than the others; 22 teeth in lower jaw, their tips shaped like arrowheads; the two large curved canines in length equal to diameter of pupil.

First few dorsal spines low, those following highest, $2\frac{1}{2}$ in head, most of fin of nearly uniform height; anal 3.5 times in head. Pectoral pointed; caudal of one specimen forked but damaged; the other nearly truncate; the minute ventral is 7 times in head.

Alcoholic specimens pale tan, lower half sprinkled with reddish-brown specks, and with more or less silvery sheen on sides of head, trunk, tail, and yellow belly; five dark-brown spots on dorsal region beneath dorsal, first above anal origin; snout dusky, area between eyes and dorsal origin dark brown. Dorsal and anal pinkish brown, densely dotted with dark-brown specks, and with a black margin. Caudal with a large red-brown basal spot, rest of fin white; pectorals and ventrals also white.

Here described from the type and paratype, both 55 mm long, collected at Lembah Strait, Celebes. The type is much bulkier than the paratype and has a longer head and trunk.

This singular blenny is included here because the type locality is so close to both Davao and the Sibutu Islands. Experience has shown that we may expect the marine fishes of the north end of Celebes to occur also in the Philippines as far north as Dumaguete, Cebu, and Samar. Probably a pelagic blenny, caught while fishing with an electric light. I do not doubt its occurrence in Philippine waters.

XIPHASIIDÆ

A family of eellike, naked blennies with the tail greatly elongated, and laterally compressed, and very long dorsal and anal, confluent with the caudal fin. Head short, eyes very large, lateral; teeth of uniform size, close together, with a pair of enormous posterior canines in lower jaw; behind these in upper jaw a pair of much smaller canines. Ventrals on throat, before gill opening, composed of three elongated and filamentous rays.

Strange looking and little-known fishes, perhaps of but a single wide-ranging species in the tropical Pacific and Indian Oceans. Several species have been described, and it is possible that two or three are valid. They are pelagic or semipelagic, occurring also on reefs off shore or in deep channels. The extraordinary canines of these fishes have excited considerable curiosity.

Genus XIPHASIA Swainson

Xiphasia SWAINSON, Nat. Hist. 2 (1839) 259.

Tail four to six times as long as head and trunk together, or even longer, and much compressed laterally, especially posteriorly; head and trunk more rounded, but also compressed, the whole body very low. Fin rays all flexible, dorsal origin over or before eyes. Gill openings small, restricted, before upper end of pectoral base and above. Branchiostegals 6.

XIPHASIA SETIFER Swainson.

Xiphasia setifer SWAINSON, Nat. Hist. 2 (1938) 259; DAY, Fishes of India (1878-1888) 337, pl. 73, fig. 1; TANAKA, Journ. Coll. Sci. Imp. Univ. Tokyo Art. 7 23 (1908) 49, pl. 4, fig. 1; HERRE, Philip. Journ. Sci. 31 (1926) 224, text fig. 1 and pl. 1.

Dorsal 123 to 126; anal 110 to 114.

Depth 33 to 36 times in length, greatest depth at back end of head and immediately behind it; Tanaka gives the depth as 38 to 47.5, but evidently measured the depth farther back. Body very elongate, eellike, laterally compressed on tail especially, which becomes ribbonlike and forms from 82 to 85 per cent of the total length. Head large, nearly as long as trunk, boldly convex anteriorly, 13 to 15 times in length, trunk 12 to 12.75 in length. Eye rather large, circular, 3.8 to 4.3 times in head. Dorsal beginning on interorbital before eyes. Caudal with the two central rays greatly elongated and hairlike, about 10 times in length.

In life bright yellow, or sometimes grayish yellow, with 28 broad dusky-brown crossbands on dorsal and body, first cross-band just behind head; dorsal and anal yellow, with broad marginal dusky band, or dorsal largely dusky; ventrals and pectorals yellow, the latter with longitudinal flesh-colored lines.

In alcoholic specimens the yellow fades, and the fins become largely brown or blackish, with the body crossed by vague, wide, pale, and blackish bars.

I have seen but one Philippine specimen, 503 mm long, obtained by Dr. J. W. Chapman, of Silliman University, Dumaguete. In addition I have collected 2 specimens, 195 and 212 mm long, at Lembeh Strait, Celebes, and have examined a specimen 370 mm long from Sagami Sea, Japan. This fish reaches a length of two-thirds of a meter, and occurs from Natal, South Africa, to Japan, and eastward in the Pacific to the New Hebrides.

CONGROGADIDÆ

Ventral fins absent, except in one form which has them jugular, and reduced to one or two filamentous rays. Body elongate, compressed, covered with very small scales, vertical fins united or caudal free. Gill membranes may be united and free from isthmus, or may be joined to it. Mouth protractile, with strongly developed lips; jaws with a single row of small conical or compressed teeth.

The family comprises reef fishes of shallow coastal waters, distributed from the Red Seas to the Philippines and Australia. The species are few, divided among 5 genera. They are rarely eaten, and are of no commercial value.

Key to the Philippine genera of Congrogadidæ.

- α^1 . No spine in front of dorsal origin..... *Congrogadus*.
 α^2 . A small sharp spine in front of dorsal origin..... *Congrogadoides*.

Genus CONGROGADUS Günther

Congrogadus GÜNTHER, Cat. Fishes 4 (1862) 388.

Body compressed, elongate, eellike, covered with very small scales; dorsal and anal both long and united with caudal. Gill openings rather wide, gill membranes united and forming a free fold across isthmus. Mouth wide, with a projecting and prominent lower jaw. Four gills, with a slit behind fourth; pseudo-branchiæ well-developed. Air bladder and pyloric appendages lacking. Vent far from head.

CONGROGADUS SUBDUCENS (Richardson).

Machærium subducens RICHARDSON, Ann. & Mag. Nat. Hist. 12 (1843) 175, pl. 6; Voy. Erebus & Terror Fishes (1844-1848) 72, pl. 44, figs. 1-6.

Congrogadus subducens GÜNTHER, Cat. Fishes 4 (1862) 388; JORDAN and RICHARDSON, Bull. Bur. Fisheries 27 (1908) 285; HERRE, Fishes 1931 Philip. Exped. (1934) 100.

Machærium nebulatum BLEEKER, Nat. Tijds. Ned. Ind. 3 (1852) 76.

This fish is known as *batad* at Cuyo.

Dorsal 71 to 76; anal 60 to 65. Scales in a longitudinal series 245 to 260; from about 35 to 40 teeth on each side of both upper and lower jaws, usually 38 to 40 in adults; lateral line ending under tenth to twelfth dorsal ray and with from 50 to 56 tubules.

Depth 8.65 to 10, head 6.5 to 6.9 times in length. Eye 6.4 to 6.7 times in head, and 1.7 to 2 times in snout. Maxillary extending to hind margin of eye or beyond, 2.1 to 2.2 times in

head; snout pointed, 3.33 to 3.8, pectoral 2.75 to 2.85 times in head.

Body elongate, strongly compressed, head sloping forward, snout keeled and steeply descending, lower jaw strongly projecting. Greatest depth may be about middle of trunk, but is usually back on tail, at least a head length behind vent. Angle of mouth beneath anterior part or middle of eye.

In life color highly variable. Specimens taken at the same time and place may be grass green, maroon, brownish red, dark brown, to pale yellowish; the color may be almost uniform, but is usually irregularly spotted with darker spots of various sizes, and sprinkled with pearly spots which may form reticulations and crossbands; under side of head and trunk usually much paler, with large pearl-colored or red spots on head, throat, and belly. Dorsal and anal with membranes uniformly dark, or one to several rows of dark spots on membrane; sometimes conspicuous dark spots along base of vertical fins. A dark spot often present on opercle; it may be a definite ocellus, but is often absent.

Alcoholic specimens usually darkening, green, red, and maroon disappearing; pearly spots and markings disappearing or else turning white, and specimens tending to become more uniform brown, yellowish, or dusky, and dull in color. The dorsal and anal may have a very narrow white or pale margin. Very young specimens are uniformly very pale yellowish, without markings, fins colorless.

I have examined many living and fresh specimens, out of which the following were kept for further study: Seven from Culion, 295 to 405 mm long; 1 from Estancia, Panay, 120 mm long; 1 from Dumaguete, Oriental Negros Province, 275 mm long; 1 from Jolo, 345 mm long; 2 from Sibutu, 108 and 118 mm long; 12 from Sitankai, 43 to 330 mm long; 3 from Sandakan, British North Borneo, 204 to 258 mm long. The Stanford Museum also contains 3 from Cuyo, 175 to 215 mm long, and 1 from Bantayan Island, 280 mm long. The smallest Culion specimen is a spawning female, full of eggs.

I place here also 22 specimens taken on a reef in Singapore Harbor, their lengths varying from 42 to 331 mm. Most of them have a more or less definite ocellus on the opercle. Several of those from 265 to 320 mm long have but 28 to 30 teeth on each side of upper and lower jaw, while others agreeing in all other respects have 35, 38, 40, and up to 44 teeth. Some of these large specimens also have only about 230 scales in a longitudinal series. These large Singapore specimens have the depth

9 to a little more than 10 times, the head 6.7 to 7.45 times in length; the eye is 6 to 6.66 times in the head and 1.66 to 1.9 times in the snout, which is 3.5 to 3.6 times in the head.

This fish is of wide occurrence in the Philippines, from Luzon southward, and is especially abundant on reefs in the Sulu Sea and the South China Sea. It is found southward and eastward through the East Indies to northern and western Australia. It reaches a length of half a meter, or perhaps a little more. Although it is plentiful around rocks on shallow reefs, and is easily taken, it is very seldom eaten, and is not sought by fishermen.

This species not only undergoes considerable change with age, but is also subject to a large amount of variation among individuals of the same size. The number of teeth has been taken as a character of specific worth, but examination of numerous individuals shows that the teeth vary widely. The very young apparently have no more than 25 teeth on upper and lower jaw. With advancing age this number increases to 30 or more, but some large individuals seem never to have more than 30. The usual number in adults is 38 to 40, with no teeth at the front end of the jaws, the space there being vacant in most specimens. Where teeth develop clear to the tip of the jaw the number is 44. Very young specimens differ from the proportions given above. The measurements and proportions used here are for specimens over 200 mm long.

Bleeker described *Machærium nebulatum* from a single specimen, 370 mm long, taken at Singapore. I can find no characters sufficient to warrant its separation as a distinct species.

Genus CONGROGADOIDES Borodin

Congrogadoides BORODIN, Copeia No. 3 (October 15, 1933) 141.

This genus, probably of only subgeneric value, differs from *Congrogadus* in having a single small, hard, sharp spine before dorsal origin. There are two species, one from the Philippines, and one known only from a single small specimen from Australia.

CONGROGADOIDES HIERICHTHYS (Jordan and Richardson).

Congrogadus hierichthys JORDAN and RICHARDSON, Bull. Bur. Fisheries 27 (December 16, 1908) 285, fig. 11; HERRE, Fishes 1931 Philip. Exped. (1934) 100.

Dorsal I, 55 to 59; anal 46 to 49; 30 to 33 tubules in lateral line, 150 to 180 scales in a longitudinal series.

Depth 7.6 to 8.2, head 6.1 to 6.5 times in length; eye 6 to 6.33, snout 3.2 to 3.45 times in head, 1.77 to 1.97 times in snout. Usually from 27 to 30 teeth on each side of each jaw, but one

specimen has only 20 teeth. Around eyes, on top of head, and on upper margins of opercle and preopercle conspicuous pores with tumid blackish lips.

The form is like that of *Congrogadus subducens*, to which this species bears a strong resemblance.

In life dark red-brown or dark brown, with sometimes more or less green on head, under parts paler; sides sprinkled with more or less evident irregular pearly or whitish spots and short vertical bars. On opercle a conspicuous very dark-red or blackish ocellus with a narrow yellow margin. Dorsal, anal, and caudal brown, variegated with darker-brown spots arranged in bands.

Alcoholic specimens dark brown or red-brown, with a more or less evident black stripe across snout, eye, and preopercle to conspicuous blackish pale-margined ocellus on opercle; sides more or less irregularly spotted with white or pale flecks and short bars. Fins dusky, or dorsal and anal pale with 2 or 4 rows of dark spots on membranes.

The type, 106 mm long, collected at Cuyo, Palawan, is in the Stanford Museum. In addition I have collected and examined a specimen 64 mm long at Dumaguete, Oriental Negros Province; 5, 97 to 123 mm long, from Jolo; and 8 at Sitankai, 71 to 123 mm long.

This fish is called *tamayo* at Cuyo.

ILLUSTRATIONS

PLATE 1

Enchelyurus cærulo-punctatus sp. nov.

PLATE 2

Petroscirtes callosoma Bleeker.

PLATE 3

Petroscirtes ferox sp. nov.

PLATE 4

Petroscirtes ferox sp. nov., enlarged, to show teeth.

PLATE 5

Lembeichthys celebesensis sp. nov.

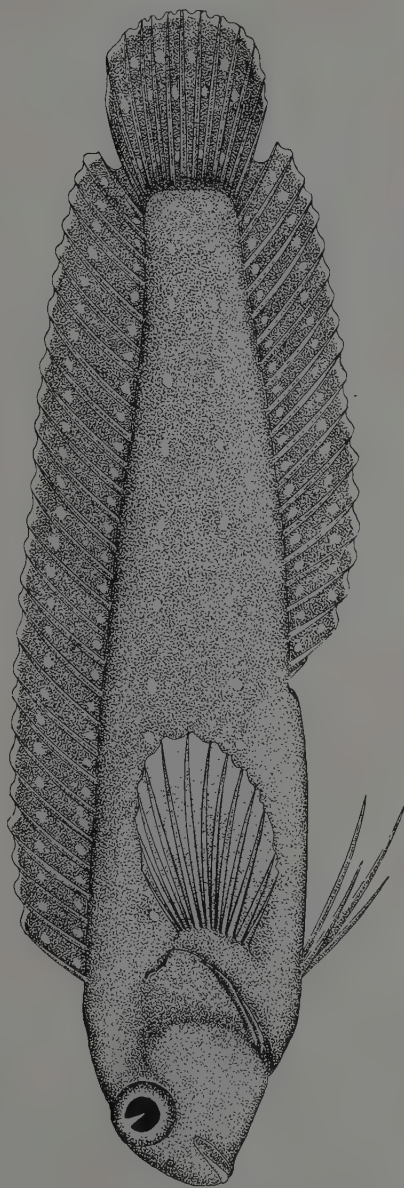


PLATE 1. ENCHELYURUS CAERULO-PUNCTATUS SP. NOV.

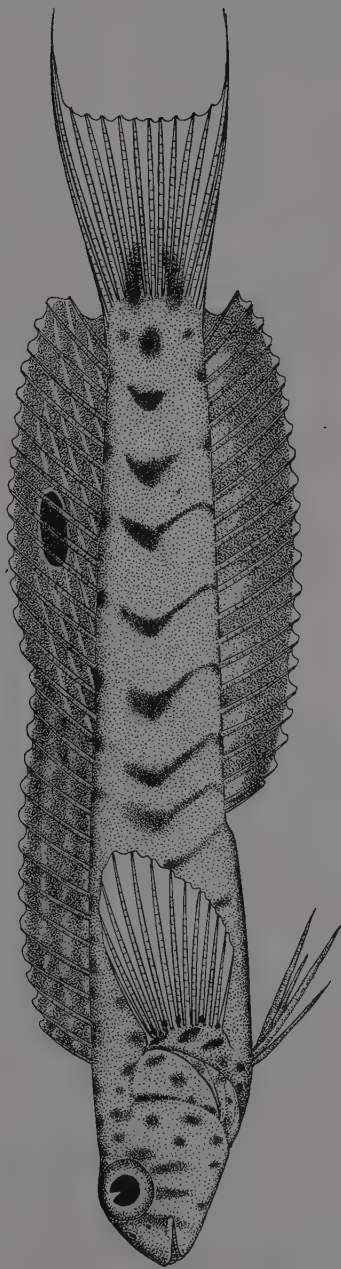


PLATE 2. PETROSCIRTES CALLOSOMA BLEEKER.

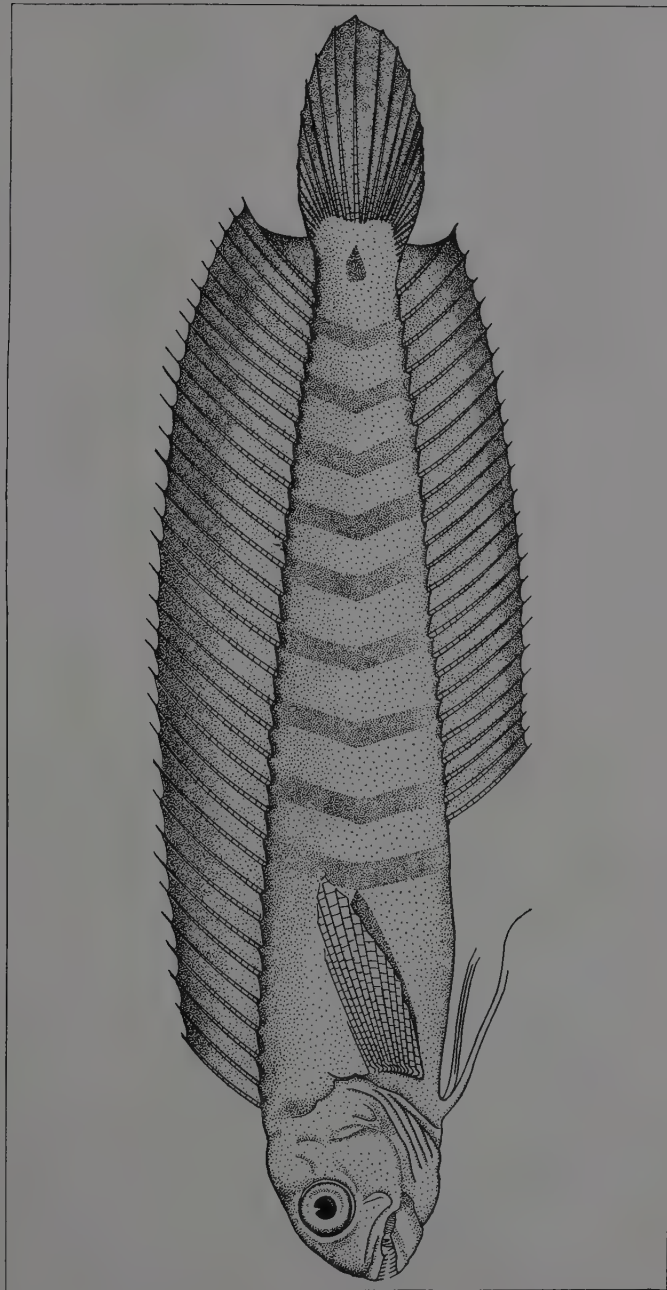


PLATE 3. PETROSIRTES FEROX SP. NOV.

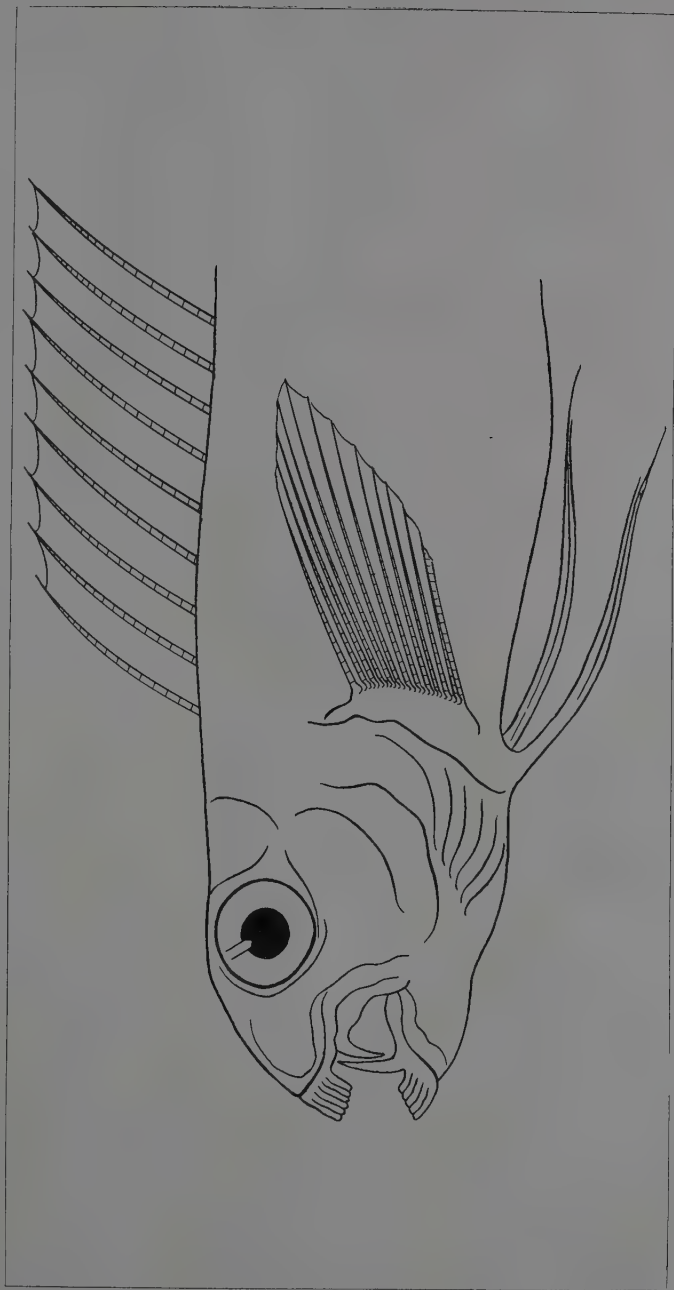


PLATE 4. PETROSCIRTES FEROX SP. NOV., ENLARGED, TO SHOW TEETH.

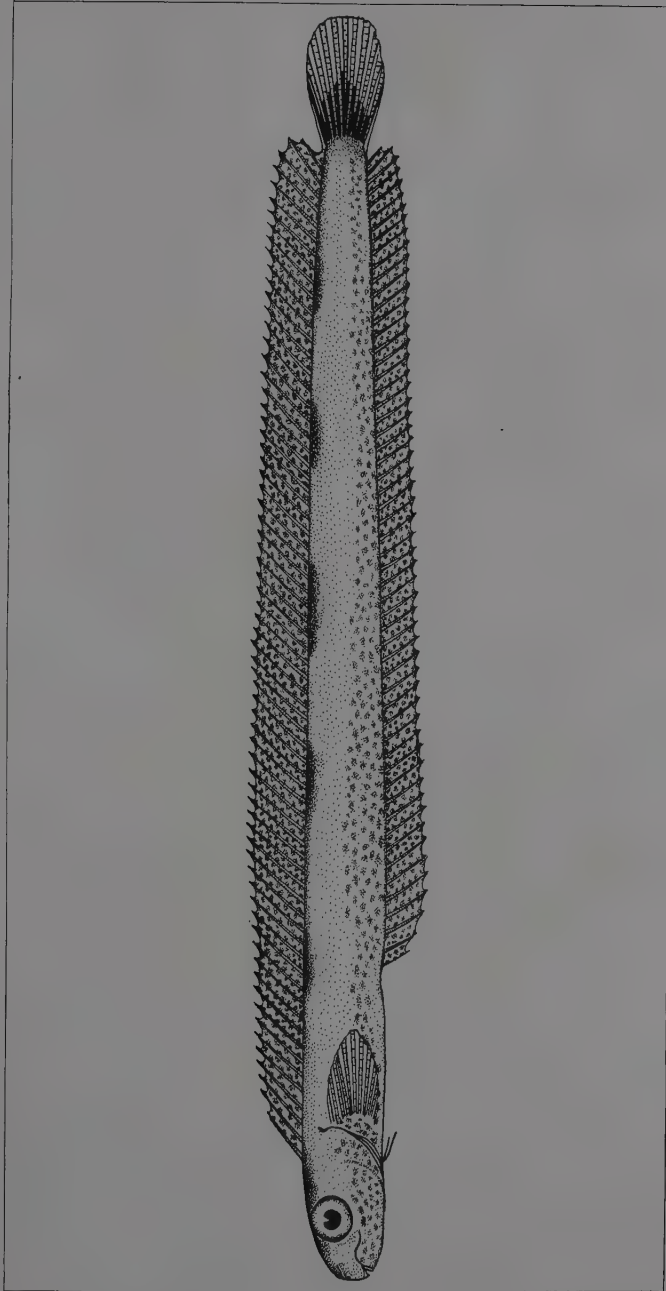


PLATE 5. LEMBEICHTHYS CELEBESENSIS SP. NOV.

VERTICAL DISTRIBUTION OF OYSTER SPAT IN BACOR BAY, CAVITE PROVINCE

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TWO PLATES AND EIGHT TEXT FIGURES

This work is undertaken to determine the depths of the water where oyster larvæ are available in abundance for purposes of finding the best methods of collecting spats and to further the development and exploitation of other oyster grounds in the Philippines.

Studies of this nature were done by Nelson(2, 3, 4) and Perkins(8) on oyster larvæ in Barnegat Bay. These workers found that oyster larvæ rise with the flood tide and sink to the bottom during the ebb. They also found that the older stages of larvæ usually move upstream and away from the sea. Their explanation was that during flood tide water of high specific gravity remains along the bottom while water of lower density rises, and a transition zone called the "salicline" or "halicline" forms between these two regions. According to these authors, larvæ of oysters or other bivalves, as well as snails, are numerous in the region of the "halicline." They explained further that during the ebb tide, especially in rough weather, the surface and bottom water mixes. As the larvæ keep close to the bottom and those of the setting size drop to the bottom, they are not carried seawards.

Prytherch(9) made an investigation on oyster larvæ in Milford Harbor, Connecticut. He found that setting was intense 1 foot above the low-water mark and 1 foot below it, gradually decreasing up to 2 feet above this mark, while directly on the bottom setting was very heavy. The reason given is that at low slack water, when setting takes place, the region of least current velocity is at the surface and does not extend to the bottom. Orton,(7) on the other hand, maintains that oyster larvæ are at the mercy of tidal currents and that their vertical migration is controlled in a measure by the power of the larvæ to swim or

to stop swimming at certain levels in the sea. He holds the opinion that oyster larvæ of all species behave similarly, and that they tend to fall to the bottom in still water in both flood tide and ebb.

The above workers agree that oyster larvæ at their setting stage reach the bottom in the process of their development and that they are present in varying quantities at different levels of the sea. Since the above conclusions are based on *microscopical* survey of the water samples taken at different regions of the sea for the presence of oyster larvæ in the plankton, the present writer decided to investigate the same problem in a *different manner*.

If the behavior of oyster larvæ is the same in all species of oysters; that is, if they tend to drop to the bottom once they reach the setting stage, more spats can be expected to set among the cultch placed at the bottom than elsewhere. The results of this investigation, however, do not bear out this expectation.

MATERIALS AND METHODS

Long collectors (Plate 1, fig. 1) as deep as the oyster beds (average low-water mark, 5 feet) were used. They were made up of pieces of No. 12 galvanized-iron wire 154 centimeters long and threaded with eleven old oyster shells of about uniform size, placed at intervals of 14 centimeters. Only clean oyster shells were used and carefully threaded onto the wire, with the smooth surface downward. The interval of 14 centimeters was maintained on the collectors with the use of a looping device (Plate 1, fig. 2) made of a piece of wood 1.5 by 4 inches by 7 feet with 11 ordinary nails 6 inches long placed at intervals of 14 centimeters. One end of the wire was looped around the eleventh nail before a shell collector was inserted. A second loop was made around the tenth nail and then a second shell collector was inserted. This process of looping the wire and inserting the shells was done alternately up to the first nail.

In this investigation a total of 44 long collectors were utilized. Two sets of 2 collectors each were placed in the Division of Fisheries oyster farm, at Binakayan, June 27 and July 5, 1938, respectively. September 1, 1938, 40 long collectors were distributed and set in the following regions in Bacoar Bay: 4 collectors among the oyster beds of Mabolo, Bacoar; 5 collectors among the oyster beds at the mouth of Bacoar River; 8 collectors among the oyster beds of Kawit; 4 collectors among the oyster

beds of Noveleta; 12 collectors in the Division of Fisheries oyster farm; 7 collectors among the oyster beds of Dalahican. All of these collectors were carefully set so that the last shell collectors touched the bottom.

Some collectors were examined for oyster spat after 21 days, and others after more than 3 months from the date of setting. A longer period of time was necessary before counting the spat, so that they could be seen easily with the naked eyes. Collectors hauled out of the water for examination were allowed to dry before the spat were counted.

RESULTS AND OBSERVATIONS

Collectors set in the Division of Fisheries oyster farm.—There were 16 collectors placed in the Division of Fisheries oyster farm bed. Two of these were set June 27 and another two July 5, 1938. These 4 collectors were removed from the water August 17, 1938, and the spat counted. The other 12 collectors were set September 1 and the spat counted November 16, 1938. Table 1 shows string collectors 1 to 4 and 21 to 32, with the corresponding number of spat caught on each shell collector. The first set of 2 string collectors is indicated in Table 2 as series 1, the second set of the same number of string collectors as series 2, and the third set of 12 string collectors as series 6. In all of these series, the sixth shell collector, placed 84 centimeters below the surface of the water, caught the most spat, 70, 81, and 147, respectively. The great difference between the average number of spat caught on shell collectors in series 1 and 2 and those of series 6 does not mean that the period between September 1 and November 16, 1938, when string collectors of series 6 was set, was a season of heavy setting of spat. Considering the number of string collectors included in series 1, 2, and 6, and taking the average number of spat caught on each shell collector at different fixed depths, series 6, which include 12 string collectors, will naturally exceed series 1 and 2, each composed of only 2 string collectors, in the average number of spat caught on each shell collector. On the other hand, the period between June 27 and August 17, 1938, when string collectors of series 1 and 2 were set, was a heavy setting season of spat, as indicated in Table 2. The average number of spat caught on the ninth shell collectors placed at 126 centimeters from the surface of the water, was 137 spat for all 44 string collectors. Out of this number 81 spat were caught on the

TABLE 1.—Collectors and number of spats caught in different regions of Bacoor Bay.

Date sgt.	Location of bed.	String collec- tor No.	Tags No.	Shells.										Total number of spat.	Date counted.
				1	2	3	4	5	6	7	8	9	10	11	
1938															
June 27	Division of Fisheries oyster farm.	1	43	9	15	25	28	31	49	30	25	23	0	0	235 Aug. 17
June 27	do.	2	22	12	11	23	19	23	21	8	1	26	0	0	144 Aug. 17
July 5	do.	3	16	8	9	43	22	13	49	33	17	4	0	0	198 Aug. 17
July 5	do.	4	63	17	10	16	19	23	32	23	41	28	0	0	209 Aug. 17
Sept. 1	Mabolo, Bacoor.	5	8	4	3	1	1	12	4	0	6	1	0	0	32 Sept. 21
Sept. 1	do.	6	47	1	9	8	3	2	4	8	6	0	0	0	41 Sept. 21
Sept. 1	do.	7	33	1	2	5	1	3	2	3	9	0	0	0	26 Sept. 21
Sept. 1	do.	8	31	1	1	4	3	8	3	18	7	0	0	0	40 Sept. 21
Sept. 1	Kawit, Cavite.	9	40	4	4	5	11	12	11	9	83	9	0	0	98 Oct. 13
Sept. 1	do.	10	10	2	4	9	4	7	25	11	0	0	0	0	62 Oct. 13
Sept. 1	do.	11	66	2	10	12	7	5	16	16	1	0	0	0	69 Oct. 13
Sept. 1	do.	12	25	7	2	8	12	10	12	1	0	0	0	0	52 Oct. 13
Sept. 1	do.	13	45	6	4	7	3	8	3	11	0	0	0	0	42 Oct. 13
Sept. 1	do.	14	52	6	5	10	6	4	22	3	2	0	0	0	53 Oct. 13
Sept. 1	do.	15	64	2	4	11	10	5	13	11	7	4	0	0	72 Oct. 13
Sept. 1	do.	16	75	5	0	2	5	8	11	10	6	0	0	0	47 Oct. 13
Sept. 1	Noveleta, Cavite.	17	34	8	2	6	2	2	9	13	23	15	12	0	90 Oct. 18
Sept. 1	do.	18	3	7	8	1	5	2	8	12	21	0	0	0	64 Oct. 18
Sept. 1	do.	19	29	1	3	12	4	9	10	12	24	0	0	0	75 Oct. 18
Sept. 1	do.	20	41	8	0	3	11	0	10	11	9	10	0	0	62 Oct. 18
Sept. 1	Division of Fisheries oyster farm.	21	14	3	2	0	3	0	8	11	6	0	0	0	33 Nov. 16
Sept. 1	do.	22	57	9	2	10	14	9	1	12	12	0	0	0	69 Nov. 16
Sept. 1	do.	23	9	22	4	2	4	10	12	9	0	0	0	0	63 Nov. 16
Sept. 1	do.	24	68	3	7	18	3	4	9	10	0	0	0	0	54 Nov. 16
Sept. 1	do.	25	30	12	0	7	17	13	24	12	4	0	0	0	39 Nov. 16
Sept. 1	do.	26	19	14	6	4	8	11	26	7	1	0	0	0	77 Nov. 16
Sept. 1	do.	27	54	14	5	7	11	7	11	9	3	0	0	0	67 Nov. 16
Sept. 1	do.	28	73	9	7	4	1	1	2	4	0	0	0	0	23 Nov. 16

Sept. 1	29	1	4	3	12	20	18	10	11	4	0	0	0	0	81	Nov. 16
Sept. 1	30	26	4	3	7	10	4	9	9	13	2	0	0	0	61	Nov. 16
Sept. 1	31	4	3	6	10	14	6	15	8	5	0	0	0	0	67	Nov. 16
Sept. 1	32	20	3	9	1	9	9	20	11	6	0	0	0	0	68	Nov. 16
Nov. 17	33	24	0	0	0	0	0	0	0	0	0	0	0	0	0	Dec. 12
Nov. 17	34	5	0	0	0	0	0	0	0	1	0	0	0	0	1	Dec. 12
Nov. 17	35	72	0	0	0	0	0	0	0	0	0	0	0	0	0	Dec. 12
Nov. 17	36	50	0	0	0	0	0	0	0	0	0	0	0	0	0	Dec. 12
Nov. 17	37	67	0	0	0	0	0	0	0	0	0	0	0	0	0	Dec. 12
Sept. 1	38	7	2	3	6	8	8	1	8	11	0	0	0	0	47	Dec. 12
Sept. 1	39	33	5	9	12	1	11	11	5	4	0	0	0	0	53	Dec. 12
Sept. 1	40	81	8	8	9	6	5	0	1	6	11	0	0	0	54	Dec. 12
Sept. 1	41	15	8	8	8	9	5	5	22	29	0	0	0	0	94	Dec. 12
Sept. 1	42	21	2	3	3	11	16	7	4	9	7	0	0	0	62	Dec. 12
Sept. 1	43	2	15	7	6	5	9	5	0	0	0	0	0	0	47	Dec. 12
Sept. 1	44	9	6	12	7	10	1	8	10	4	0	0	0	0	58	Dec. 12

ninth shell collectors of series 1 and 2, and only 2 spat were caught on the ninth shell collectors of series 6. Text figs. 1, 2, and 3 show that the tenth and eleventh shell collectors placed at depths of 140 and 154 centimeters, respectively, are without

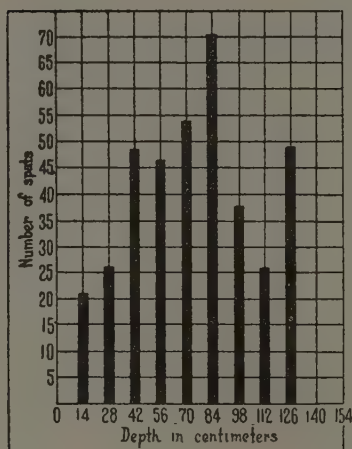


FIG. 1. Average number of spat caught on shell collectors set from June 27 to August 17, 1938, in the Division of Fisheries oyster farm.

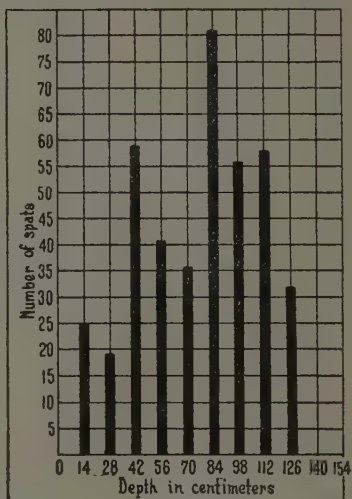


FIG. 2. Average number of spat caught on shell collectors set from July 5 to August 17, 1938, in the Division of Fisheries oyster farm.

TABLE 2.—Number of spat caught on shell collectors at fixed distances from the surface of water.

Shell collector.	Depth.	No. of spat.							Average.
		Series 1.	Series 2.	Series 3.	Series 4.	Series 5.	Series 6.	Series 7.	
	cm.								
1	14	21	25	7	34	24	100	46	257
2	28	26	19	15	33	13	54	50	210
3	42	48	59	13	64	22	82	51	344
4	56	47	41	8	58	22	114	50	340
5	70	54	36	20	59	20	92	55	236
6	84	70	31	13	118	41	147	37	507
7	98	38	56	29	72	58	113	50	416
8	112	26	58	28	49	69	54	68	347
9	126	49	32	1	13	22	2	18	137
10	140	0	0	0	0	0	0	0	0
11	154	0	0	0	0	0	0	0	0
Total		379	407	139	500	291	753	420	

spat. This is also true in the case of the other string collectors set in the different regions of Bacoar Bay. This result may be due to the muddy condition of the bottom of oyster beds in the entire Bay, where the mud is about 2 feet deep and not compact.

A slight movement of water, caused by waves and current, stirs the surface of the muddy bottom so that the layer of water along the surface becomes silty, and silt seems to have a deleterious effect on the life of oyster spat. Even mature oysters raised by the hanging method of oyster culture die whenever they drop to the muddy bottom. When some of those still alive were examined, much silt was found adhering along the sides of the mantle cavity and among the gill filaments.

Collectors set among the oyster beds in Mabolo, Bacoar.—Four string collectors were set in this place September 1 and examined for oyster spat September 21, 1938. Table 1 shows string collectors 5, 6, 7, and 8 together with the number of spat caught on the individual shell collectors. This set of string collectors is indicated as series 3, and Table 2 gives the average number of spat caught on shell collectors at fixed distances from the surface of the water. Only 139 spat

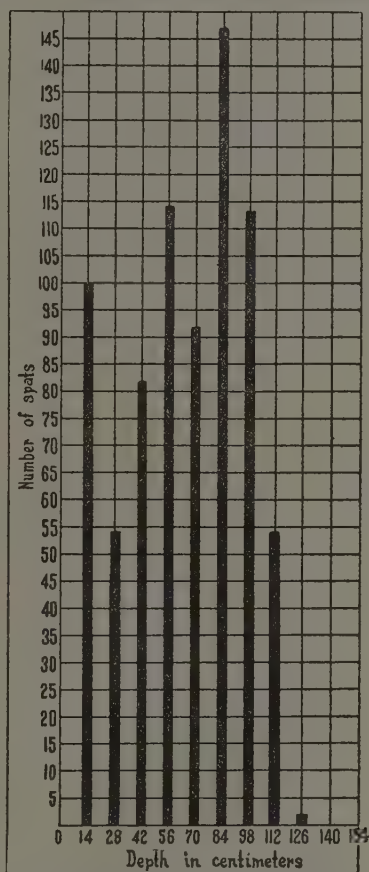


FIG. 3. Average number of spat caught on shell collectors set from September 1 to November 16, 1938, in the Division of Fisheries oyster farm.

were caught on these collectors, due probably to the shorter period of time these collectors had stayed under water as compared with that of the other collectors. Moreover, the oyster beds found along the shore of the town of Bacoar are not as

productive and conducive to the development and growth of spat as those found along the shores of Binakayan, Kawit, Noveleta, and Dalahican. The bottom of oyster beds along the shore of

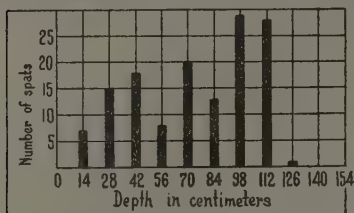


FIG. 4. Average number of spat caught on shell collectors set from September 1 to 21, 1938, in Mabolo, Bacoor, Cavite Province.

the town of Bacoor is constantly disturbed as a result of the daily gathering of shells which are used in the manufacture of lime.

Collectors set among the oyster beds in Noveleta.—

Four string collectors were set in Noveleta September 1

and the spat counted October 18, 1938. Table 1 shows string collectors 17 to 20 together with the number of spat caught on each shell collector. In Table 2

this set of collectors is indicated as series 5. It will be noticed

that numerous spat were found on the eighth shell collectors placed at a depth of 112 centimeters from the surface of the water. Text fig. 5 shows the average number of spat caught on shell collectors set in this region of Bacoor Bay. At depths of from 42 to 70 centimeters from the surface there was a very slight decrease in the number of spat caught, while a sudden increase was attained at from 84 to 112 centimeters from the surface of the water.

Collectors set among the oyster beds in Dalahican.—

Seven string collectors were set in Dalahican September 1, and the spat counted December 12, 1938. Table 1 shows collectors 38 to 44, together with the spat caught on each shell collector. These collectors are indicated in Table 2 as series 7. Fig. 7 indicates that spat

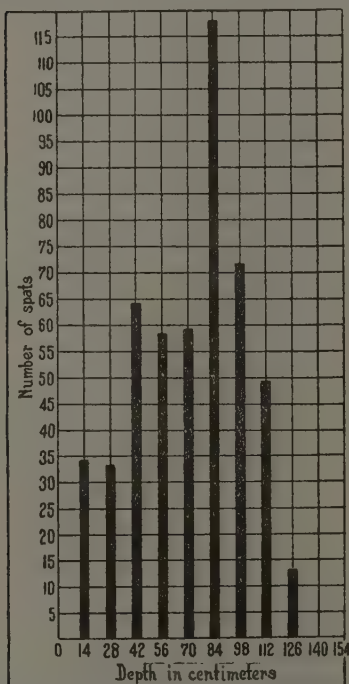


FIG. 5. Average number of spat caught on shell collectors set from September 1 to October 13, 1938, in Kawit, Cavite Province.

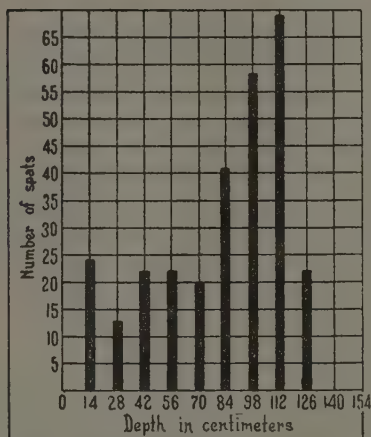


FIG. 6. Average number of spat caught on shell collectors set from September 1 to October 18, 1938, in Noveleta, Cavite Province.

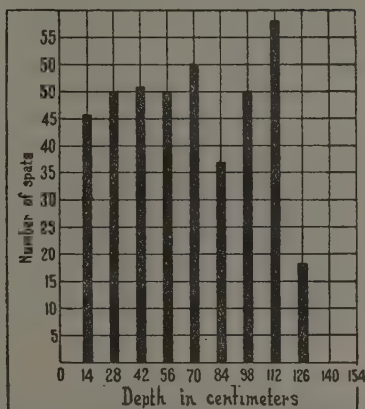


FIG. 7. Average number of spat caught on shell collectors set from September 1 to December 12, 1938, in Dalahican, Cavite Province.

were almost evenly distributed at depths of from 14 to 112 centimeters from the surface, except at the region of the sixth shell collector at a depth of 84 centimeters where the average number of spat was only 37. Spat were absent at depths of from 140 to 154 centimeters from the surface of the water.

Collectors set at the mouth of Bacoor River.—Five string collectors were set at the mouth of Bacoor River November 17 and the spat counted December 12, 1938. Table 1 shows collectors 33 to 37. Only string collectors 34 and 37 were able to catch

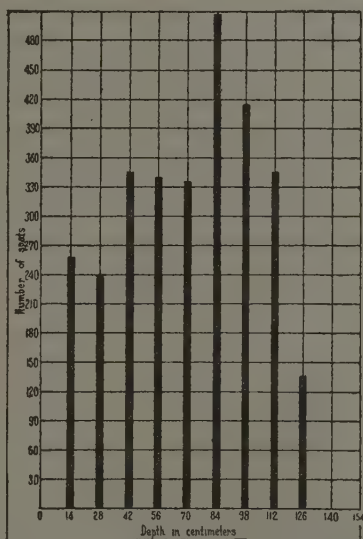


FIG. 8. Vertical distribution of spat in Bacoor Bay.

one spat each on shell collectors 8 and 4, respectively, due probably to the occurrence of heavy rainfall during the period covered by the experiment, which may have caused the water at the mouth of the river to become fresh and unsuitable for the life of oyster spat. Also, the mouth of Bacoor River has a heavy deposit of sand and mud which caused the water to become silty. Nelson⁽⁶⁾ has shown that oyster larvæ, while in muddy water, fill the digestive tract with dirt instead of with their ordinary food. He also observed that oyster larvæ in the laboratory fed with fine suspension of mud die within a day or two, while larvæ placed in clear sea water are able to live for 10 days.

DISCUSSION OF RESULTS

The average number of spat caught on string collectors in Bacoor Bay is given in Table 3. The 16 string collectors set in the Division of Fisheries oyster farm at Binakayan caught the greatest number of spat, 96 being the average number caught on each string collector. The 4 string collectors set among the oyster beds in Noveleta ranked second, with 72 as the average number of spat caught on each shell collector. The collectors set among the oyster beds in Kawit, Dalahican, and Mabolo, ranked third, fourth, and fifth, respectively, with 62, 60, and 34 spat, respectively, to each string collector. The 5 string collectors set at the mouth of Bacoor River caught only 2 spat.

TABLE 3.—Average number of spat caught on string collectors in Bacoor Bay.

Location of bed.	Number of string collectors.	Number of spat caught.	Average number of spat per collector.
1. Binakayan.....	16	1,544	96
2. Noveleta.....	4	291	72
3. Kawit.....	8	500	62
4. Dalahican.....	7	420	60
5. Mabolo.....	4	139	34
6. Bacoor River (mouth).....	5	2	

Text fig. 8 presents the vertical distribution of oyster spat in Bacoor Bay, at fixed depths from the surface of the water to the bottom. It will be seen that spat are available in abundance at depths of from 42 to 112 centimeters from the surface of the water. The greatest intensity of setting is obtained at 84 centimeters from the surface of the water. The figure also

shows the presence of a considerable number of spat at a depth of 28 centimeters from the surface of the water, whereas in about the same place they are totally absent at the same distance from the bottom.

SUMMARY AND CONCLUSIONS

1. Oyster spat are available at depths ranging from 14 to 126 centimeters from the surface of the water. They are abundantly present at a depth of 84 centimeters from the surface, while at depths ranging from 140 to 154 centimeters they are totally absent in the oyster beds in Bacoar Bay.

2. To catch the maximum number of spats in Bacoar Bay it is necessary that all string collectors be not less than 112 centimeters long from the surface of the water.

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ILLUSTRATIONS

PLATE 1

- FIG. 1. Spat collectors, 154 centimeters long.
2. A piece of wood with nails for making loops between shell collectors.

PLATE 2

Bunches of oyster seeds, 3 months and 19 days old, from the Division of Fisheries oyster farm, Binakayan.

TEXT FIGURES

- FIG. 1. Average number of spat caught on shell collectors set from June 27 to August 17, 1938, in the Division of Fisheries oyster farm.
2. Average number of spat caught on shell collectors set from July 5 to August 17, 1938, in the Division of Fisheries oyster farm.
3. Average number of spat caught on shell collectors set from September 1 to November 16, 1938, in the Division of Fisheries oyster farm.
4. Average number of spat caught on shell collectors set from September 1 to 21, 1938, in Mabolo, Bacoor, Cavite Province.
5. Average number of spat caught on shell collectors set from September 1 to October 13, 1938, in Kawit, Cavite Province.
6. Average number of spat caught on shell collectors set from September 1 to October 18, 1938, in Noveleta, Cavite Province.
7. Average number of spat caught on shell collectors set from September 1 to December 12, 1938, in Dalahican, Cavite Province.
8. Vertical distribution of spat in Bacoor Bay.

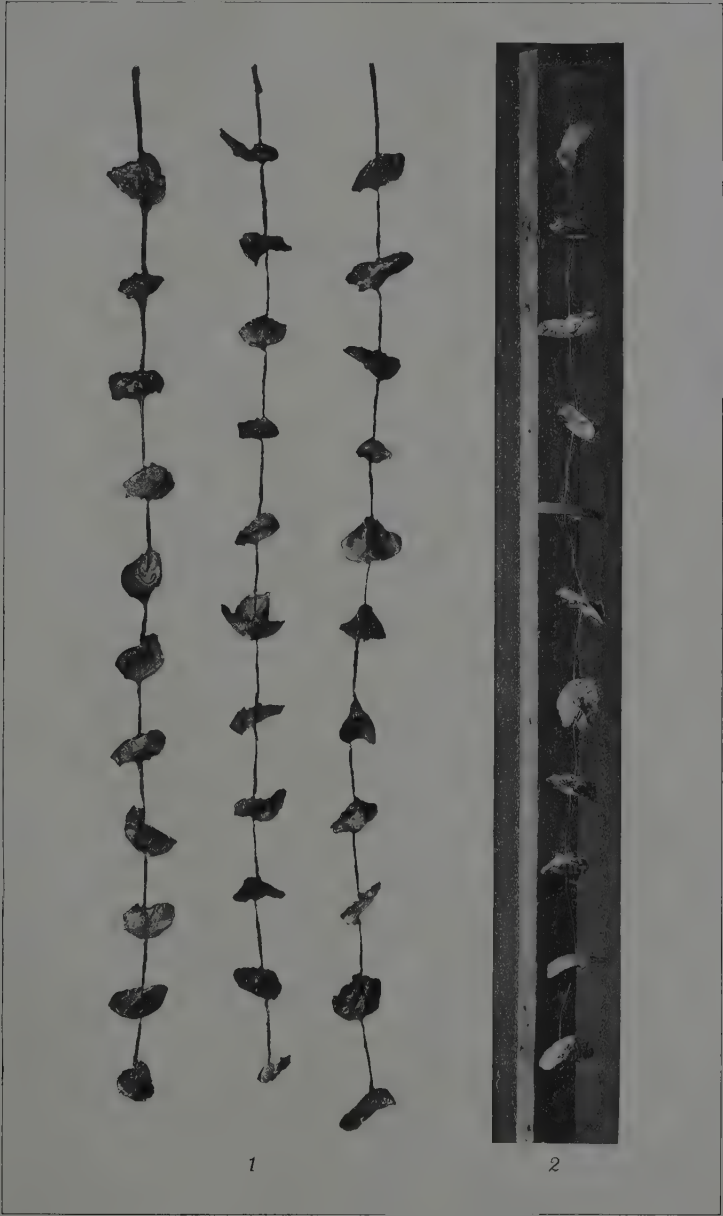


PLATE 1.

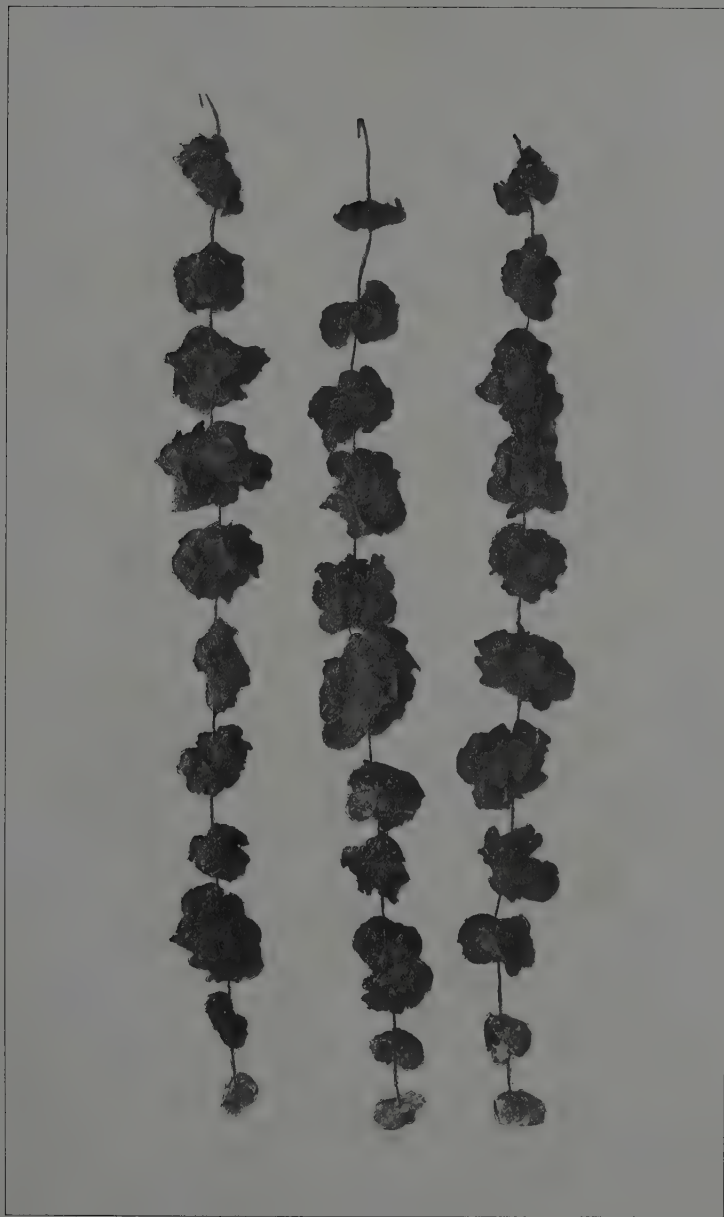


PLATE 2.

FOUR NEW PHILIPPINE SPECIES OF FRESH-WATER SHRIMPS OF THE GENUS CARIDINA

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Manila*

THREE PLATES

The description of these apparently new species of shrimps is based upon material collected from Laoag River, Laoag, Ilocos Norte Province, December 31, 1938, by Mr. Eulogio J. Martinez, and from a mountain stream, Helosig, Leyte, 1,500 feet above sea level, May 23, 1937, by Messrs. Dioscoro S. Rabor and M. Celestino, both of the Division of Fisheries, Bureau of Science.

Genus CARIDINA Milne-Edwards

Caridina MILNE-EDWARDS, *Histoire Naturelle des Crustacés* 2 (1837).

CARIDINA VILLADOLIDI sp. nov. Plate 1, figs. 1 to 9.

Rostrum straight, saberlike, nearly reaching level of antennal scale; upper edge without teeth; lower edge with 6 teeth on distal half of its total length; a pair of setæ posterior of rostrum (Plate 1, fig. 1). Antennal spine sharp; anteroinferior angle of carapace sharp-pointed. Eyes normal. Antennular peduncle reaching beyond tip of spine of antennular peduncle scale; basal segment not reaching beyond half of length of rostrum; second segment long, twice its width. Antennal scale slender, three times as long as broad. Mandible with three spines of incisor process and setæ (Plate 1, fig. 2). Terminal joint of third maxilliped (Plate 1, fig. 3) with eight spines and numerous setæ. Carpus of first peræopod (Plate 1, fig. 4) twice as long as distal breadth, excavation at distal end slightly crescent-shaped. Hairs of mobile and immobile fingers of chela not very long. Palm of chela of second peræopod not similar to that of first; distal end of carpus not excavated (Plate 1, fig. 5). Dactylus of third pair (Plate 1, fig. 6) with seven spines; that of fifth pair (Plate 1, fig. 7) with 44 spinules. Body robust, dorsally rounded, depth of second abdominal somite twice in body. Pleopods short and foliaceous. Apex of telson (Plate 1,

fig. 8) triangular, with a sharp midpoint, two curved-in externo-lateral spines, and seven internolateral unequal spines with setæ. Uropodial spinules 17 in each.

Eggs 0.50 mm long, 0.36 wide.

Type locality.—Laoag River, Laoag, Ilocos Norte Province, Luzon.

Live specimens grayish with small specks. Preserved specimens yellowish. One type specimen, Cat. No. 40, 26 mm from tip of rostrum to tip of telson.

I take pleasure in naming this species after Dr. Deogracias V. Villadolid, zoölogist of the Division of Fisheries, Department of Agriculture and Commerce.

Caridina villadolidi is closely related to *C. angulata* Bouvier with respect to the number of spines of the dactylus of the third and fifth pair of peræopods and diameter of eggs. It differs, however, from the latter by having 17 uropodial spinules, instead of 19 or 20, as in *C. angulata*. The apex of the telson and the basal angle of the uropodial spines of this new species also differ greatly from those of *C. angulata*.

CARIDINA LAOAGENSIS sp. nov. Plate 2, figs. 1 to 8.

Rostrum short, slightly curved downwards, not reaching third segment of antennule; upper border with 12 to 18 teeth; lower border with 4 or 5 teeth (Plate 2, fig. 1). Antennal spines below eye orbit sharp-pointed; anteroinferior angle of carapace not rounded. Eyes normal, two times as long as broad, ocellus distinct (Plate 2, fig. 2). Antennular peduncle not reaching beyond tip of spine of antennal scale; basal segment reaching beyond first posterior tooth of lower border of rostrum. Antennal scale three times as long as broad. Terminal joints of third maxilliped not reaching beyond antennular peduncle. Mandible (Plate 2, fig. 3) with five spines of incisor process and setæ. Carpus of first pair of peræopods as long as distal breadth; excavation at distal end crescent-shaped. Mobile and immobile fingers of chela with short hairs (Plate 2, fig. 4). Carpus of second pair of peræopods 4.75 times as long as broad (Plate 2, fig. 5). Dactylus of third pair with seven spines and setæ (Plate 2, fig. 6). Body robust, depth of second abdominal somite twice in length of body. Pleopods short, foliaceous. Telson 1.33 times as long as sixth somite, with three pairs of dorsal spines; apex of telson with two pairs of setæ, with two small externolateral spines, two pairs of similar spines, and in between two pairs

of unequal long setæ. Uropodial spinules 20 in each outer uropod.

Eggs 0.43 mm long and 0.29 wide.

Live specimens blackish with a yellow narrow band on dorsal side of body. Preserved specimens dark orange.

Type, Cat. No. 41, and several cotypes, 20 to 25 mm long from tip of rostrum to tip of telson.

Caridina laoagensis is allied to *C. annandalei* Kemp and *C. lævis* Heller with respect to the rostrum which does not reach the end of the antennular peduncle or beyond the antennal scale. It resembles *C. lævis* with respect to the excavation at the distal end of the carpus of the first pair of peræopods, but differs from *C. annandalei* by having no excavation on the distal end of the carpus. *C. laoagensis* is very distinct, because it has a greater number of spinules on its outer uropods, and the apex of its telson is not similar to that in other species of the genus. The eggs are smaller than those of *C. annandalei*.

CARIDINA LEYTENSIS sp. nov. Plate 3, figs. 1 to 7.

Rostrum straight, short, not reaching beyond end of second segment of antennular peduncle. Upper border with eight to ten teeth; lower border with one or no teeth. Antennal spine sharp-pointed; anteroinferior angle of carapace not rounded (Plate 3, fig. 1). Breadth of cornea 1.75 dorsal length of eye; ocellus distinct. Antennular peduncle not reaching beyond tip of spine of antennal scale. End of basal segment of antennular peduncle reaching beyond last posterior of the upper edge of rostrum. Second segment of antennular peduncle 2.33 times as long as broad. Terminal joint of third maxilliped (Plate 3, fig. 2) with four spines and setæ. Carpus of first peræopod (Plate 3, fig. 3) twice as long as distal breadth; no excavation on distal end. Hairs of mobile and immobile fingers short. Carpus of second peræopod (Plate 3, fig. 4) about five times as long as wide; distal end of carpus not excavated. Dactylus of third with four spines and setæ (Plate 3, fig. 5). Body slightly compressed, sixth somite twice as long as wide. Pleopods long, foliaceous. Apex of telson triangular, with two small external spines and four pairs of internolateral spines, six of which are equal in length, the two extremes longer than the inner four. Uropodial spinules 14.

Type locality.—Helosig, Leyte.

Type, Cat. No. 42, and cotype, both 7 mm long from tip of rostrum to tip of telson.

Caridina leytenensis is closely related to *C. kilimæ* Hilgendorf in the shape of the rostrum, but differs by having a greater number of spinules of the outer uropods, and in the shape of the apex of its telson.

CARIDINA CELESTINOI sp. nov. Plate 3, figs. 8 to 10.

Rostrum short, not reaching beyond end of basal segment of antennular peduncle; upper edge with one tooth; lower edge without teeth but with a pair of setæ. Antennal spine acutely pointed, anteroinferior angle also acutely pointed. Eyes 1.75 times as long as broad, ocellus well-marked. Antennular peduncle (Plate 3, fig. 8), reaching tip of lamella of antennal scale. Dorsal and ventral ends of basal segment and second segment with spinules and setæ. Second segment of antennular peduncle 1.75 times as long as wide dorsally. Terminal joint of third maxillipeds reaching beyond tips of antennal scale and antennular peduncle. Carpus of first peræopod (Plate 3, fig. 9) 2.75 times as long as distal breadth; no excavation of distal end. Telson with two pairs of dorsal spines as long as sixth somite dorsally. Mountain stream, Helosig, Leyte.

Preserved specimen dark yellowish.

Type, Cat. No. 43, 4 mm long.

Caridina celestinoi is very distinct from other known species in the character of its rostrum, which has one tooth at the middle of the upper edge and a pair of long setæ on the lower edge.

I take pleasure in naming this dwarf shrimp after Mr. Manuel Celestino, one of the collectors of the specimens.

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ILLUSTRATIONS

[All drawings were made by Guillermo J. Blanco, with the aid of a camera lucida.]

PLATE 1. *CARIDINA VILLADOLIDI* SP. NOV.

FIG. 1. Lateral view of rostrum, $\times 30$; 2, mandible, $\times 50$; 3, terminal segment of third maxilliped, $\times 30$; 4, chela and carpus of first peræopod, $\times 30$; 5, chela and portion of carpus of second peræopod; 6, dactylus of third pair, $\times 50$; 7, dactylus of fifth pair, $\times 30$; 8, portion of telson, $\times 50$; 9, uropodial spinules, $\times 50$.

PLATE 2. *CARIDINA LAOAGENSIS* SP. NOV.

FIG. 1. Lateral view of rostrum, $\times 30$; 2, eye, $\times 30$; 3, mandible, $\times 50$; 4, chela, carpus, and propodus of first pair of peræopods, $\times 30$; 5, chela and carpus of second pair of peræopods, $\times 30$; 6, dactylus of third pair of peræopods, $\times 50$; 7, portion of telson; 8, uropodial spinules, $\times 50$.

PLATE 3

FIG. 1. *Caridina leytenensis* sp. nov., lateral view, anterior cephalothorax, $\times 50$; 2, *Caridina leytenensis* sp. nov., terminal joint of third maxilliped, $\times 30$; 3, *Caridina leytenensis* sp. nov., peræopod of first pair, $\times 60$; 4, *Caridina leytenensis* sp. nov., peræopod of second pair, $\times 60$; 5, *Caridina leytenensis* sp. nov. dactylus of third pair, $\times 60$; 6, *Caridina leytenensis* sp. nov., apex of telson, 60; 7, *Caridina leytenensis* sp. nov., uropodial spinules, $\times 60$; 8, *Caridina celestinoi* sp. nov., lateral view, anterior cephalothorax, $\times 50$; 9, *Caridina celestinoi* sp. nov., peræopod of first pair, $\times 50$; 10, *Caridina celestinoi* sp. nov., lateral view of telson and uropods, $\times 50$.

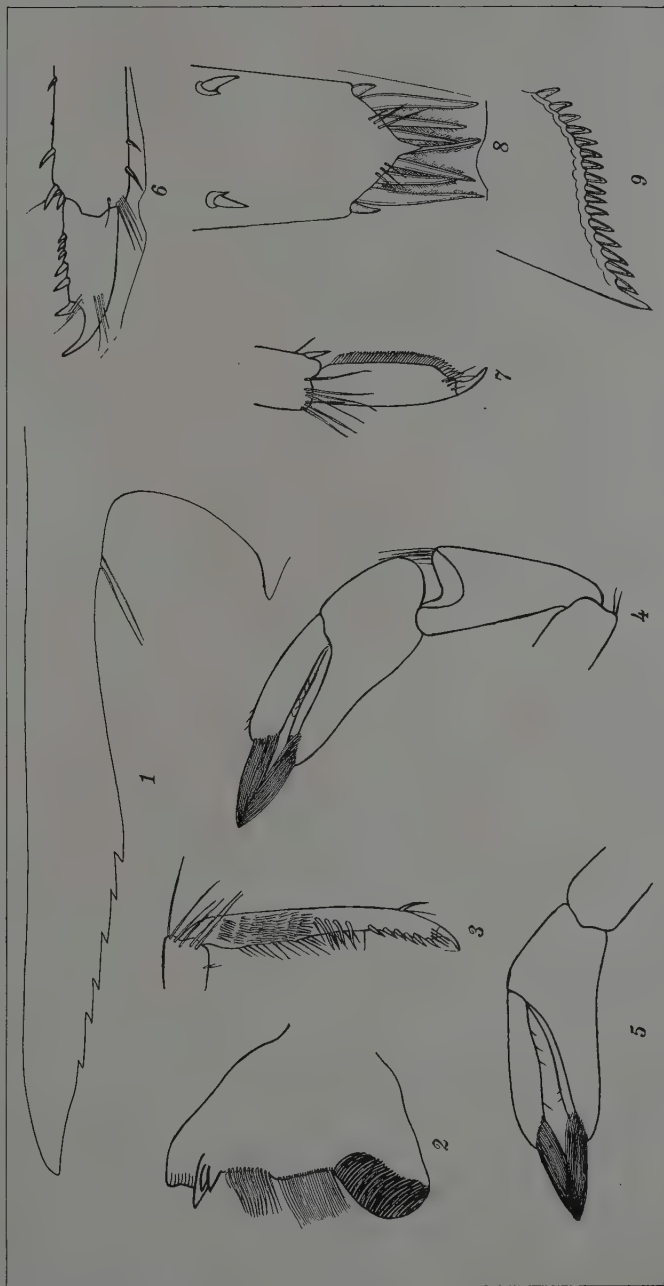


PLATE 1. CARIDINA VILLADOLIDI SP. NOV.



PLATE 2. *CARIDINA LAOAGENSIS* SP. NOV.

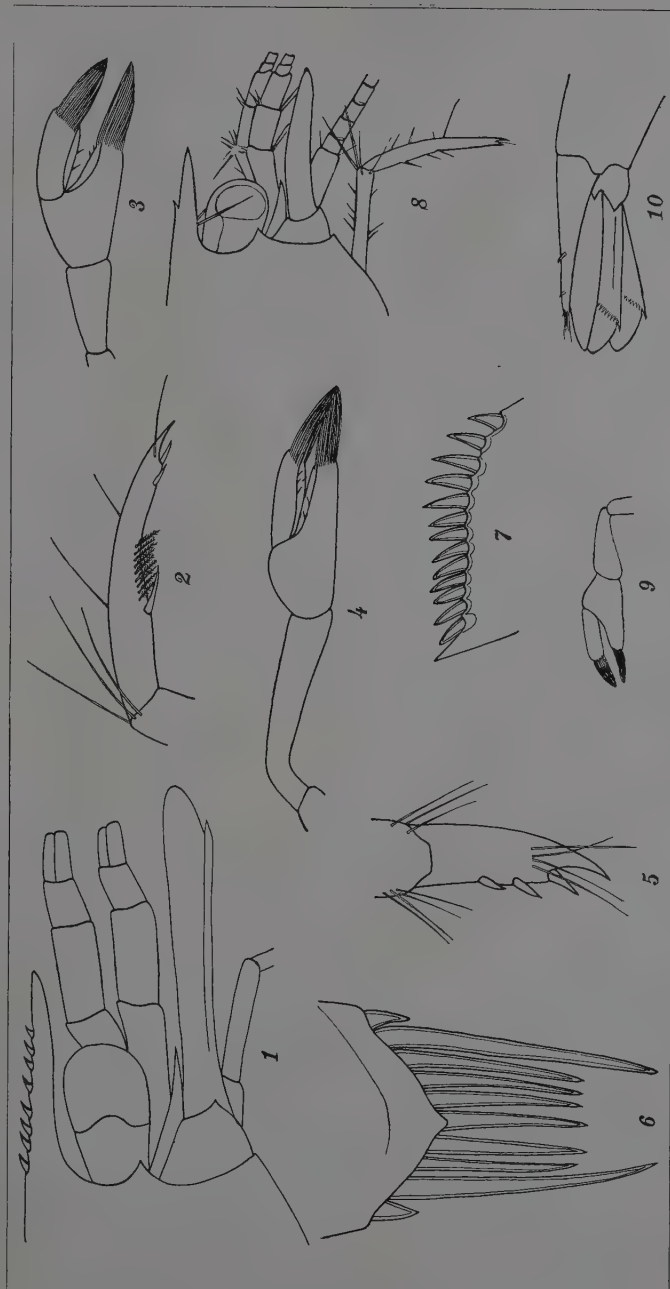


PLATE 3.

CLINOSTOMUM ABDONI SP. NOV., A TREMATODE
PARASITE OF THE CAT IN THE PHILIPPINES

By MARCOS A. TUBANGUI
Of the Bureau of Science, Manila

and

EUSEBIO Y. GARCIA
Of the Institute of Hygiene, Manila

ONE TEXT FIGURE

A single specimen of this interesting parasite was recently received by one of us (E. Y. G.) from Dr. Alfredo Abdon with the information that it was obtained from a pocket under the tongue of a house cat in Surigao, Surigao Province, Mindanao. The finding of the fluke in a mammal is of more than ordinary interest, due to the fact that all of the previously described members of the genus *Clinostomum* have all been encountered in the oral cavity, pharynx, or œsophagus of fish- and frog-eating birds. It is probable that the new form is also normally a bird parasite, the cat being only an incidental host. We have the pleasure of naming the parasite after Doctor Abdon in appreciation of his interest and his courtesy in placing the material at our disposal.

Description.—Body elongate, measuring 6.8 millimeters in length by 1.65 millimeters in maximum width across middle of postacetabular region; preacetabular region more or less uniform in width. Cuticle unarmed. Oral sucker terminal, 0.30 by 0.40 millimeter, partially retracted, with the anterior body wall raised around it like a collar. Acetabulum much larger than oral sucker, 0.86 by 0.64 millimeter, at junction of anterior and middle thirds of body length. Prepharynx long, pharynx rudimentary, œsophagus practically absent; intestinal cæca with short lateral evaginations in postacetabular region, extending to near posterior end of body.

Testes tandem, small, kidney-shaped, 0.20 by 0.40 millimeter, at middle of posterior third of body length. Cirrus sac ventral to anterior testis, bottle-shaped, 0.60 by 0.19 millimeter, its neck bent acutely towards median line; cirrus sac incloses small seminal vesicle and short cirrus. Common genital pore median, immediately in front of anterior testis.

Ovary pear-shaped, 0.27 by 0.16 millimeter, slightly displaced towards right side of median line and partly overlapping posterior testis in ventral view. Shell gland as large as and beside

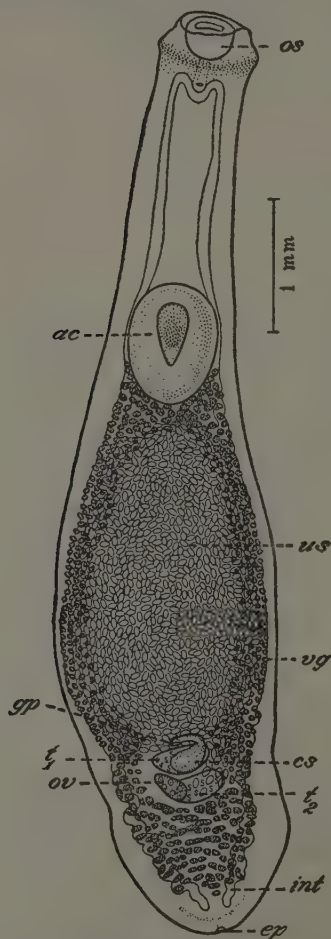


FIG. 1. *Clinostomum abdoni* sp. nov., entire worm, ventral view. ac, acetabulum; os, cirrus sac; ep, excretory pore; vp, genital pore; int, intestinal caecum; os, oral sucker; ov, ovary; t₁, t₂, testes; us, uterine sac; vg, vitelline glands.

ovary, ventral to posterior testis. Uterine sac enormously distended with eggs, 2.45 by 0.95 millimeters, occupying much of the space between acetabulum and anterior testis. Vitellaria follicular, in two broad lateral bands between acetabulum and posterior end of body, meeting anteriorly and posteriorly. Eggs thick-shelled, operculated, yellowish, none-embryonated, 100 to 109 by 60 to 64 microns.

Excretory bladder V-shaped; excretory pore terminal.

Host.—House cat (*Felis catus domesticus*).

Location.—Mouth cavity, under tongue.

Locality.—Surigao, Surigao Province, Mindanao.

Type specimen.—Bureau of Science parasitological collection No. 579.

Two species of immature clinostomes have been described from the Philippines; namely, *Clinostomum dalagi* Tubangui, 1933, from a fish, and *C. pseudoheterostomum* Tubangui, 1933, from a frog. *Clinostomum abdoni* differs very markedly from both of these forms. It appears to be more closely related to *C. lophophallum* Baer, 1933,

which was collected from the mouth of a heron, *Phoyx purpurea manillensis* (Meyer)¹ in Macassar, Celebes. It may be distinguished from its near relative by its smaller body size, the more posterior location of the main reproductive organs, the shaped of the testes, the position of the genital pore in front of the first testis, the greater development of the uterine sac, and the smaller size of the eggs.

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¹ The eastern purple heron also occurs in many islands of the Philippines.

ILLUSTRATION

TEXT FIGURE

[Drawing by Baldomero Escuadro.]

FIG. 1. *Clinostomum abdoni* sp. nov., entire worm, ventral view. *ac*, acetabulum; *cs*, cirrus sac; *ep*, excretory pore; *gp*, genital pore; *int*, intestinal cæcum; *os*, oral sucker; *ov*, ovary; *t*₁, *t*₂, testes; *us*, uterine sac; *vg*, vitelline glands.

DIATOMS IN THE STOMACHS OF MARINE ANIMALS FROM AMOY AND VICINITY

By T. G. CHIN

Of the Marine Biological Station, University of Amoy, China

Diatoms are the grasses of the ocean and the basic food of marine animals. Therefore the study of the stomach contents, or the contents of the alimentary canals of marine animals, may yield a large number of diatoms. Diatoms are especially numerous in those small forms in which, by means of the cilia, sea water is made to circulate in and out of the body. The food-getting apparatus of this type of animal is better fitted than the finest tow net for collecting diatoms and other small organisms.

The present paper covers 12 samples, representing 11 species of animals, 9 of them invertebrates, and 2 protochordates. Eighty-eight species of diatoms were obtained from the stomachs of these animals, 24 of them new for China coast, mostly *Navicula*, 5 of them brackish-water species, and 5 fresh-water species.

Sample 1.—Collected from the small oyster, *Ostrea talienwhanensis*, Kulangsu, June, 1937. Fourteen species of diatoms were found.

Sample 2.—Collected from the small oyster, *Ostrea talienwhanensis*, Chipbee, June, 1937. Nineteen species were found.

Sample 3.—Collected from the large oyster, *Ostrea gigas*, Chuan Chow, April, 1937. Twenty-one species were found.

Sample 4.—Collected from *Solen* sp., Amoy, June, 1937. Fourteen species were found.

Sample 5.—Collected from *Pinna* sp., Nantaiwu, August and September, 1936. Twenty-one species were found.

Sample 6.—Collected from *Lingula* sp., Chipbee, April, 1937. Twenty-eight species were found.

Sample 7.—Collected from the purple sea urchin, *Heliocidariscrassispina*, Nantaiwu, April, 1936. Twenty-nine species were found.

Sample 8.—Collected from the sea cake, *Peronella lesseuri*, Chipbee, August, 1936. Twelve species were found.

Sample 9.—Collected from many species of the sea cucumber, from different localities near Amoy, 1936. Eleven species were found.

Sample 10.—Collected from the sipunculus, *Phymosoma scolops*, Amoy Harbour, spring, 1937. Seventeen species were found.

Sample 11.—Collected from amphioxus, *Branchiostomata* sp., Liuwutien, June, 1937. Thirty species were found.

Sample 12.—Collected from the purple ascidian, *Cynthia rosea*, Chipbee, June, 1936. Twenty-six species were found.

DIATOMS FOUND

MELOSIRA MONILIFORMIS (Müll.) Agardh.

Sample 1.

MELOSIRA JUERGENSI Agardh.

Sample 5.

PARALIA SULCATA (Ehr.) Cleve.

Sample 3.

HYALODISCUS SUBTILIS Ball.

Samples 2 and 3.

PODOSIRA STELLIGER (Bail.) Mann.

Samples 2, 3, 4, 5, 6, 11, and 12.

STEPHANOPYXIS PALMERIANA (Grev.) Grunow.

Sample 9.

ACTINOCYCLUS EHRENBERGI Ralfs.

Samples 2, 4, 7, 11, and 12.

ACTINOCYCLUS EHRENBERGI var. CRASSA (W. Sm.) Hustedt.

Sample 2.

COSCINODISCUS LINEATUS Ehrenberg.

Samples 1, 2, 3, 4, 5, 6, 7, 10, 11, and 12.

COSCINODISCUS EXCENTRICUS Ehrenberg.

Samples 1, 2, 3, 4, 5, 6, 7, 8, 9, 11, and 12.

COSCINODISCUS SUBTILIS (Ehr.) Grunow.

Samples 1, 2, 3, 4, 7, 8, 10, and 12.

COSCINODISCUS CURVATULUS Grunow.

Samples 2, 5, 7, 8, 10, and 12.

COSCINODISCUS CURVATULUS var. **MINOR** (Ehr.) Grunow.

Coscinodiscus curvatus var. *minor* (Ehr.) Grunow, HUSTEDT (1928) 409, fig. 217.

Sample 2.

COSCINODISCUS EXCENTRICUS var. **FASCICULATA** Hustedt.

Coscinodiscus excentricus var. *fasciculata* HUSTEDT (1928) 390, fig. 202.

Sample 2. First record for China Coast.

COSCINODISCUS STELLARIS Roper.

Coscinodiscus stellaris Roper, HUSTEDT (1928) 396, fig. 207.

Samples 2 and 3. First record for China Coast.

COSCINODISCUS STELLARIS var. **SYMBOLOPHORA** (Grun.) Jorgensen.

Coscinodiscus stellaris var. *symbolophora* (Grun.) Jorgensen, HUSTEDT (1928) 396, fig. 208.

Sample 2. First record for China Coast.

COSCINODISCUS RADIATUS Ehrenberg.

Samples 3, 6, 7, 8, 9, 10, and 12.

COSCINODISCUS MARGINATUS Ehrenberg.

Samples 7, 11, and 12.

COSCINODISCUS ASTEROMPHALUS Ehrenberg.

Samples 7, 9, 10, and 11.

COSCINODISCUS JONESIANUS var. **COMMUTATA** (Grun.) Hustedt.

Sample 8.

CYCLOTELLA STRIATA (Kütz.) Grunow.

Samples 1, 4, 5, 6, 10, 11, and 12.

CYCLOTELLA STYLORUM Brightwell.

Samples 1, 2, 3, 6, and 11.

CYCLOTELLA COMTA (Ehr.) Kützing.

Samples 2, 4, 6, 7, 10, 11, and 12.

CYCLOTELLA CHAETOCERAS Lemmermann.

Cyclotella chaetoceras Lemmermann, HUSTEDT (1928) 344, fig. 175.

Sample 3. First record for China Coast.

ARACHNODISCUS ORNATUS Ehrenberg.

Samples 7 and 10.

ACTINOPTYCHUS UNDULATUS (Bail.) Ralfs.

Samples 1, 3, 5, 6, 7, 9, 11, and 12.

ASTEROMPHALUS ROBUSTUS Castr.

Samples 10 and 12.

AULISCUS INCERTUS Schmidt.

Auliscus incertus Schmidt, HUSTEDT (1929) 522, fig. 296.

Sample 2. First record for China Coast.

TRICERATIUM FAVUS Ehrenberg.

Samples 3, 4, and 11.

TRICERATIUM BALEARICUM fo. **BIQUADRATA** (Janisch) Hustedt.

Triceratium balearicum fo. *biquadrata* (Janisch) HUSTEDT (1930) 813, fig. 477.

Sample 7. First record for China Coast.

TRICERATIUM BROECKII Leudiger-Fortmorel.

Triceratium Broeckii Leudiger-Fortmorel, HUSTEDT (1930) 802, fig. 465.

Sample 11. First record for China Coast.

ACTINOPTYCHUS ANNULATA (Wall.) Grunow.

Samples 1, 4, 5, 6, 7, 10, 11, and 12.

BIDDULPHIA MOBILIENSIS (Bail.) Grunow.

Sample 1.

BIDDULPHIA AURITA (Lyn.) Brebisson.

Sample 2.

BIDDULPHIA AURITA var. **OBTUSA** (Kütz.) Hustedt.

Sample 3.

BIDDULPHIA PULCHELLA Gray.

Samples 7 and 11.

BIDDULPHIA OBTUSA Kützing.

Samples 7 and 10.

RAPHONEIS AMPHICEROS Ehrenberg.

Samples 5 and 6.

SYNEDRA GALLIONII Ehrenberg.

Samples 4, 9, and 12.

SYNEDRA TABULATA (Ag.) Kützing.

Sydnedra tabulata (Ag.) Kützing, VAN HEURCK (1896) 314, pl. 10, fig. 431.

Sample 5. First record for China Coast.

SYNEDRA ULNA Ehrenberg.

Synedra ulna Ehrenberg, VAN HEURCK (1896) 310, pl. 10, fig. 409.

Sample 6. Fresh-water species.

SYNEDRA ROBUSTA Ralfs.

Synedra robusta Ralfs, VAN HEURCK (1896) 316, pl. 30, figs. 836, 837.

Sample 7. First record for China Coast.

RHABDONEMA ADRIATICUM Kützing.

Sample 7.

GRAMMATOPHORA MARINE var. **MACILENTA** van Heurck.

Samples 7 and 8.

ACHNANTHES BREVIPES Agardh.

Samples 5, 7, and 9.

COCCONEIS SCUTELLUM Ehrenberg.

Samples 1, 5, and 7.

COCCONEIS DISRUPTA Greg.

Sample 7.

NAVICULA FUSCA (Greg.) Ralfs.

Navicula fusca (Greg.) Ralfs, DONKIN (1870) 7, pl. 1, fig. 5.

Sample 1. First record for China Coast.

NAVICULA INTERRUPTA Kützing.

Samples 1, 4, 5, and 6. Brackish-water species.

TRACHYNEIS ASPERA Ehrenberg.

Samples 2, 3, 5, 6, 7, 11, and 12.

NAVICULA CRABRO Ehrenberg.

Samples 3, 6, 7, 8, 11, and 12.

NAVICULA ELLIPTICA Kützing.

Navicula elliptica Kützing, DONKIN (1870) 7, pl. 1, fig. 6.

Samples 4, 5, 6, 9, 10, 11, and 12. First record for China Coast. Brackish-water species.

NAVICULA BOMBUS (Ehr.) Kützing.

Navicula bombus (Ehr.) Kützing, DONKIN (1870) 50, pl. 7, fig. 7.

Sample 5. First record for China Coast. Brackish-water species.

NAVICULA LITORALIS Donkin.

Navicula litoralis DONKIN (1870) 5, pl. 1, fig. 2.

Samples 6 and 10. First record for China Coast.

NAVICULA LYRA Ehrenberg.

Navicula Lyra Ehrenberg, DONKIN (1870) 14, pl. 2, fig. 7.

Samples 6 and 11. First record for China Coast.

NAVICULA NITESCENS Greg.

Navicula Nitescens Greg., DONKIN (1870) 8, pl. 1, fig. 7.

Samples 6 and 11. First record for China Coast.

NAVICULA FORTIS Greg.

Sample 6.

NAVICULA SCOPULORUM Brebisson.

Navicula scopulorum Brebisson, DONKIN (1870) 73, pl. 12, fig. 5.

Samples 6 and 7.

NAVICULA FORCIPATA Greville.

Navicula forcipata Greville, DONKIN (1870) 12, pl. 2, fig. 4.

Sample 9. First record for China Coast.

NAVICULA LONGA Greg.

Sample 11.

NAVICULA DIRECTA W. Sm.

Sample 11.

NAVICULA ABRUPTA Greg.

Sample 11.

PINNULARIA TABELLARIA Ehrenberg.

Pinnularia Tabellaria Ehrenberg, DONKIN (1870) 70, pl. 12, fig. 4.

Sample 6. Fresh-water species.

TRACHYNEIS CLEPSYDRA (Donkin) Cleve.

Trachyneis Clepsydra (Donkin) Cleve, DONKIN (1870) 63, pl. 10, fig. 2.

Samples 11 and 12. First record for China Coast.

GOMPHONEIS GRACILE Ehrenberg.

Gomphoneis gracile Ehrenberg, VAN HEURCK (1896) 272, pl. 7, fig. 309.

Sample 1. Fresh-water species.

CYMBELLA ASPERA (Ehr.) Cleve.

Sample 4. Fresh-water species.

CYMBELLA ASPERA var. **MINOR** van Heurck.

Cymbella aspera var. *minor* VAN HEURCK (1896) 146, pl. 1, fig. 36.

Samples 3 and 4. Fresh-water species.

AMPHORA SALINA W. Sm.

Samples 5 and 6. Brackish-water species.

AMPHORA COMMUTATA Grunow.

Amphora commutata Grunow, VAN HEURCK (1896) 132, pl. 1, fig. 13.

Sample 11. First record for China Coast.

PLEUROSIGMA NORMANII Ralfs.

Samples 2, 3, 5, 6, 9, 10, 11, and 12.

PLEUROSIGMA PELAGICUM Peragallo.

Pleurosigma pelagicum Peragallo, ALLEN & CUPP (1935) 157, fig. 104.

Samples 6, 11, and 12. First record for China Coast.

PLEUROSIGMA AFFINE Grunow.

Pleurosigma affine Grunow, VAN HEURCK (1896) 252, pl. 6, fig. 263.

Samples 7 and 8.

PLEUROSIGMA NAVICULACEUM Brebisson.

Samples 8, 11, and 12.

GYROSIGMA BALTICUM W. Sm.

Samples 2 and 3.

SURIRELLA FLUMINENSIS Grunow.

Samples 1, 3, 5, 7, 9, 10, and 11.

SURIRELLA SPIRALIS Kützinger.

Surirella spiralis Kützinger, VAN HEURCK (1896) 374, pl. 13, fig. 592.

Sample 3. First record for China Coast.

SURIRELLA GEMMA Ehrenberg.

Samples 6 and 8.

SURIRELLA VOIGTII Skvortzow.

Surirella voigtii SKVORTZOW (1932) 160, pl. 1, figs. 1 to 3; pl. 2, fig. 1.

Samples 8 and 10.

CAMPYLODISCUS HODGSONII W. Sm.

Sample 7.

CAMPYLODISCUS (?) COCCONEIFORMIS Grunow.

Samples 3, 5, 7, 10, 11, and 12.

NITZSCHIA LANCEOLATA W. Sm.

Nitzschia lanceolata W. Sm., VAN HEURCK (1896) 400, pl. 17, fig. 548.

Samples 1 and 6. First record for China Coast. Brackish-water species.

NITZSCHIA PUNCTATA (W. Sm.) Grunow.

Samples 5, 6, 7, 9, 11, and 12.

NITZSCHIA PUNCTATA var. **ELONGATA** van Heurck.

Nitzschia punctata var. *elongata* VAN HEURCK (1896) 385, pl. 15, fig. 492.

Sample 8. First record for China Coast.

NITZSCHIA FASCICULATA Grunow.

Nitzschia fasciculata Grunow, VAN HEURCK (1896) 397, pl. 16, fig. 536.

Sample 12. First record for China Coast.

NITZSCHIA LONGISSIMA (Breb.) Ralfs.

Sample 12.

BACILLARIA PARADOXA (Gmel.) Grunow.

Sample 12.

GOMPHONITZSCHIA CHINENSIS Skvortzow.

Gomphonitzschia chinensis SKVORTZOW (1932) 159, pl. 3, fig. 1.

Sample 6.

STICTODESMIS AUSTRALIS Greville.

Stictodesmis Australis Greville, VAN HEURCK (1896) 236, fig. 34.

Sample 8. First record for China Coast.

A METHOD FOR DEGUMMING AND BLEACHING DECORTICATED RAMIE FIBER

By MARIANO P. RAMIRO

Of the Bureau of Science, Manila

Decorticated ramie is a gummy bast fiber of the ramie plant (*Boehmeria nivea* L.), debarked and separated from the woody portion by a decorticating machine. It is often called China grass, ramie ribbon, or simply ramie. Locally the plant is known as *lipang aso* (Tag.). If purified properly its strong fibers become lustrous like silk, and suitable for the manufacture of high-grade textiles. Since the production of ramie is a growing industry, it would seem important to develop an economical and effective method for degumming decorticated ramie grown in the Philippines.

Ramie was the source of textile fiber in the early Egyptian dynasties, and since that time it has been rediscovered several times. The early Chinese wove fiber from ramie into a delicate, beautiful "grass cloth." Today other oriental countries are using it for the same purpose as well as in the manufacture of cordage.

The ramie plant is a "cluster of tuberous roots(8) surrounded by a mass of fleshy rootlets, supporting a growth of from 10 to 80 stalks which shoot upward to a height of from 4 to 8 feet." The stalks vary in diameter from five-sixteenths to three-fourths of an inch at maturity. The leaves of ramie are ovate-acuminate, green on the upper surface, and hairy and silvery or whitish beneath. The bast fibers are imbedded in the bark that surrounds the woody portion of the tree.

For years the inhabitants of the Batanes Islands and the non-Christian people of northern Luzon have cultivated and extensively used ramie for various purposes.

The plant was introduced into Davao from Formosa in 1931 by the Ohta Development Company. It has been reported(4) that six crops can be obtained annually in Mindanao. Under normal conditions a hectare of ramie in Davao yields forty piculs of decorticated fiber. The cost of producing a picul of the fiber

in Davao is estimated at 12 pesos.¹ At this rate it would mean a net profit of 18 pesos per picul to producers, since the current price of one picul is 30 pesos.

In other ramie-producing countries (Table 1) the planters can obtain only from one to four crops a year. It thus appears that the ramie industry in the Philippines has advantages and possibilities over such an industry in other countries.

TABLE 1.—Annual yield of decorticated ramie fiber, in pounds per hectare.

Countries.	Number of cuttings.	Pounds per hectare.
Philippines (Calinisan).....	6	^a 5,340
Algiers (Hardy).....	3	^b 8,150
California (Hilgard).....	2-4	^b 4,000
France (Favier).....	3	^b 3,300
India (Spon).....	2	^b 1,250
Italy (De Mass).....	2	^b 2,800

^a Figures taken from Calinisan.

^b Figures taken from Dodge.

Calinisan states that in 1936 there were four plantations in Davao, comprising 176 hectares, of which 100 hectares belong to the Ohta Development Company, 50 hectares are credited to the Catalanana Agricultural Company, 20 hectares are registered under the Furukawa Plantation, and 6 hectares are developed by the Pendisaan Plantation.

According to Lomat,⁽¹¹⁾ the Ohta and Furukawa Companies in the early part of 1938 owned over 300 hectares of ramie, and exported 600 piculs of decorticated ramie to Japan.

Degummed China grass is glossy and looks almost like silk. This property of the fiber, combined with its strength which is eight times that of cotton,⁽⁵⁾ makes ramie a valuable material for the manufacture of textiles and paper. The degummed fiber is also a source of alpha cellulose that may be converted into artificial silk and other products. The purified filaments have been woven into a variety of goods, such as table cloths, napkins, curtains, dress goods, and knit materials.⁽¹²⁾

In Europe, particularly France, Germany, and England, ramie is used for linen,⁽⁹⁾ drawn-work doilies, and other textile goods.⁽⁷⁾ In the paper industry ramie pulp is known as an excellent material for bank notes⁽¹⁰⁾ and writing paper of high quality.

¹ One peso equals 50 cents United States currency.

Spun ramie fiber has been made into incandescent mantles(1) superior to those made of cotton.

PREVIOUS WORK ON DEGUMMING

To render ramie suitable for the manufacture of high-grade textiles or of substitutes for textile materials, it has to be economically degummed. Several methods for degumming the fiber have been reported in literature.(3, 5, 6, 13, 14)

As a result of numerous preliminary experiments there was developed in this laboratory a method that seems to be very suitable for local conditions.

EXPERIMENTAL PROCEDURE

Analytical.—For industries that use fibrous plants as their basic raw material, the composition of the plant is a matter of considerable importance. In general the results of analyses give an idea of the quality of the fiber, and also the properties of the incrusting substances. A knowledge of these components is essential in refining the fiber.

A quantitative determination was made of the different constituents of the raw material and of the purified fiber. For the former (Table 3) the sample was extracted with alcohol-benzol, followed in succession by cold-water extraction and a digestion with 1 per cent sodium hydroxide. The total cellulose was determined from the residue. In another case, for each component of the raw material determined, a different original sample was used.

In the analysis of the purified fiber the standard method used by the Forest Products Laboratory(2) of the United States department of Agriculture was adopted.

Degumming.—The fiber was digested in 2 stages of 1.5 hours each, in a dilute solution of caustic soda or a mixture of dilute solution of caustic soda and ammonium carbonate in the first stage, and a combination of caustic soda and sodium sulphite in the second. The proportions of the chemicals used for digestion are shown in Table 10, in which experiments 27 and 28 gave the best results. The total volume of cooking liquor used for every 36 grams of oven-dry fiber is approximately 400 cubic centimeters.

Bleaching.—Sodium hypochlorite was used in bleaching the degummed fiber. Twenty-seven grams of the fiber was placed in a suitable container with 400 cubic centimeters of water heated to 40° C. The sodium hypochlorite solution containing 22 grams per liter of available chlorine was added, with constant stirring so that it mixed well with the fiber. The container, which was frequently shaken, was placed in a bath of 40° C. and maintained at this temperature until the bleaching liquor was completely exhausted. The fiber was then carefully washed and dried.

Softening.—To render the degummed ramie soft and flexible, it was treated for 1 to 2 hours with an emulsion consisting of soap solution and kerosene. Before drying, the emulsion was either partially or completely washed out with tap water.

RESULTS

Analysis.—The difference observed in the cellulose content of the decorticated and the undecorticated fiber (Tables 2 and 3) is to be expected, because the bark which is intact in the undecorticated material dissolves readily in the process of analysis.

TABLE 2.—Total cellulose from undecorticated fiber.* (Cross and Bevan method.)

Sample No.	Weight of material used, ^b	Cellulose.	
		g.	Per cent.
1.....	2.1192	.9910	46.70
2.....	1.7940	.9132	50.80
3.....	1.7940	.9450	52.65
4.....	1.7940	.9472	52.75
Average.....			50.72

* Samples in this determination were grown in Manila.

^b Oven dry.

TABLE 3.—Composition of decorticated ramie fiber, calculated on dry weight.

Composition.	Per cent.
Cellulose (ash free)	83.51
Alcohol-benzol extract	2.15
Cold-water soluble	3.57
Alkali soluble	9.95
Ash (in cellulose)	0.21

The decorticated fiber does not give any reaction for ligneous bodies. The absence of such bodies perhaps accounts for the rapid isolation and purification of the fiber. Alcohol and alcohol-benzol extracts are small (Table 4), indicating the resistance of the gum to the action of organic solvents. The relative difference in the ash content of the untreated and the treated fiber (Tables 3 and 4, respectively), shows that the mineral constituents are readily dissolved during the isolation of the cellulose. More or less complete elimination of the mineral components during the degumming and bleaching processes is further disclosed by the small difference in the ash content of the fiber purified by the Cross and Bevan method, and the alpha cellulose shown in Tables 3 and 5, respectively.

TABLE 4.—*Constituents and extract of decorticated fiber, determined separately from original individual sample.*

Component.	Method used.	Per cent.
Cellulose.....	Chlorination.....	84.15
Alcohol extract.....	Soxhlet extraction.....	2.53
Alcohol-benzol extract.....	do.....	2.15
Hot-water soluble.....	Reflux with H ₂ O for 1 hr.....	3.14
Cold-water soluble.....	Digestion with distilled H ₂ O for 48 hours.....	2.29
Alkali soluble.....	Digestion with 1% NaOH for 1 hour.....	15.46
Moisture.....	Oven drying at 105°C.....	9.70
Ash.....	Obtained by incineration from untreated sample.....	4.05

TABLE 5.—*Analysis of degummed ramie fiber compared with that of commercial rayon pulp.*

Material.	Alpha cellulose.	Ash.	Soluble in 10 per cent KOH.	Copper number.	Beta and gamma cellulose.
	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>		<i>Per cent.</i>
Degummed ramie fiber.....	96.01	0.11	4.24	0.79	^b 3.88
Highly purified wood pulp ^a	95.08	0.08	5.45	1.04	-----
Rayon pulp now on the market ^a	87.76	0.12	11.39	1.93	-----

^a Schwarz, E. W. K., and H. R. Mauersberger, *Rayon and Synthetic Yarn Handbook* (1936) 53.

^b Estimated by difference.

Digestion.—A comparative study of all the experiments recorded in Tables 6, 7, 8, 9, and 10 indicates that the concentration of the cooking liquor has some effect on the digestion yield. The average yield of the samples treated with a relatively strong solution (in the first and second digestion, Table 6) is

TABLE 6.—Two-stage digestion, each followed by bleaching.

Sample No.	Materials used (oven dry), g.	1st digestion.		Color of bleached fiber. ^a	2d digestion.				Bleach, NaOCl, ^b cc.	Color of bleached fiber.	Yield. Per cent.
		NaOH, 4 per cent solution.	Time, Hrs.		NaOH, 1 per cent solution.	Na ₂ SO ₄ 2 per cent solution.	(NH ₄) ₂ CO ₃ , g.	Time, Hrs.			
1	27.51	cc.	400	gray	cc.	200	300	2.0	cc.	grayish	75.80
2	30.57	400	1.0	yellowish	360	360	360	1.5	10	white	73.30
3	36.24	450	1.0	gray	100	400	400	3	10	fairly white	73.70
4 ^c	36.60	400	1.5	do	100	400	400	3	8	do	66.00
5	34.80	400	1.5	light brown	100	400	400	4	8	do	73.50
6	35.72	400	1.5	brownish	200	200	200	1.3	8	yellowish	70.30
7	35.72	400	1.5	do	200	200	4	1.5	8	do	70.00
8	35.72	400	1.3	light brown	200	200	4	1.5	8	do	69.20
9	35.72	400	1.3	brownish	200	200	3	2.0	8	do	71.00
10	36.00	200	1.5	do	200	200	3	1.5	8	do	74.45
11	36.00	200	1.5	gray	200	200	4	1.5	8	do	73.65

^a Five cc bleach liquor containing 23 grams available chlorine per liter was used.^b Contains 22 grams available chlorine per liter.^c This sample was moldy.

TABLE 7.—Effect of water pretreatment on the degumming of 36 grams^a of ramie fiber.[Bleach used: 5 cc sodium hypochlorite.^b]

Sample No.	Time.	Color change.	Yield.
	<i>Hrs.</i>		<i>Per cent.</i>
12.....	7	none.....	95.60
13.....	7	do.....	95.67
14.....	22	slightly bleached.....	94.62
15.....	22	do.....	94.82

^a Oven dry.^b Contains 22 grams available chlorine per liter.TABLE 8.—Degumming of ramie fiber, 1st digestion.^a[Sodium hydroxide, 200 cc 1 per cent solution. Bleach used, 15 cc sodium hypochlorite.^b]

Sample No. ^c	(NH ₄) ₂ CO ₃ .	Color of bleached fiber.	Yield.
	<i>g.</i>		<i>Per cent.</i>
12.....	4	yellow.....	86.40
13.....	5	do.....	87.05
14.....		yellowish.....	78.70
15.....	8	do.....	79.72

^a All digestions were made in 2 hours.^b Contains 22 grams available chlorine per liter.^c Products from water pretreatment were used.TABLE 9.—Degumming of ramie fiber, 2d digestion.^a[Bleach used: 7 cc sodium hypochlorite.^b]

Sample No. ^c	NaOH, 1 per cent solution.	Color of bleached fiber.	Yield.
	<i>cc.</i>		<i>Per cent.</i>
12.....	50	yellow.....	79.80
13.....	60	do.....	80.35
14.....	50	slightly yellowish.....	75.60
15.....	25	yellowish.....	76.37

^a All digestions were made in 1.5 hours.^b Contains 22 grams available chlorine per liter.^c Products from first digestion were used.

TABLE 10.—Two-stage digestion^a followed by one-stage bleaching.

[Thirty-six grams (oven dry) of material were used in all samples.]

Sample No.	1st digestion, NaOH, 1 per cent solution.	Second digestion.			Bleach NaOCl. ^b	Color of bleached fiber.	Yield.
		NaOH, 1 per cent solution.	Sodium sulphite, 2 per cent solution.	(NH ₄) ₂ CO ₃ .			
	cc.	cc.	cc.	g.	cc.		Per cent.
18.....	50		50		10	yellowish.....	79.50
19.....	50	50			10	do.....	78.70
20.....	900	25			8	fairly white.....	74.80
21.....	250	75			8	do.....	73.42
22.....	150	50	50	3	8	some fiber unbleached.....	78.05
23.....	200	50	50	3	8	streaky with unbleached fiber.....	75.35
24.....	50	50	50	3	8	poorly bleached.....	79.82
25.....	100	50	50	3	8	unbleached.....	78.20
26.....	350	50	50	3	5	yellowish.....	75.03
27.....	400	50	50	3	5	lustrous white.....	73.90
28.....	370	50	25		5	do.....	73.97
29.....	350		50		7	streaky.....	
30.....	350			6	7	slightly yellowish.....	76.58
31.....	300	water	water		7	yellowish.....	77.28
32.....	300	40			7	do.....	76.43
33.....	200	100	100		7	white.....	74.21
34.....	200	100	50		7	fairly white.....	75.30

^a All digestion lasted 1.5 hours.^b Contains 22 grams available chlorine per liter.

definitely lower than the yield of the samples (Tables 7, 8, 9, and 10) treated with a cooking solution of moderate concentration. Since digestion and bleaching in all cases took place under uniform conditions, the difference in yield must be due to the concentration of the cooking liquor. This observation agrees with the usual experience in the digestion of fibrous material; that is, the stronger the liquor, the lower the yield, other conditions being equal.

When the product was treated with acid, the best results in yield and bleach requirements were obtained under the following conditions: The cooking liquor for the first digestion should have 9.25 grams of sodium hydroxide per liter. The solution for the second digestion, consisting of a mixture of sodium sulphite and caustic soda, should contain 1.25 grams per liter each.

An increase in the ratio of the digestion chemical to the fiber did not seem to improve the bleach consumption of the product. This is shown in samples 6, 7, 8, 9, 10, and 11 in Table 6, and the samples in Tables 7, 8, and 9 in which the fiber was not treated

with a dilute acid. It would seem, therefore, that the purification of the fiber is not dependent entirely on the strength of the cooking solution.

In experiments in which dilute acid was used, the bleach requirements of the fiber were small in comparison with the bleach demand for samples (Tables 6, 7, 8, and 9) having no acid treatment. In almost all cases the bleach demand of the samples in Tables 6, 7, 8, and 9 was about three times the amount of bleach used in samples 27 and 28 (Table 10) which were washed with the acid after digestion or before bleaching.

Under these conditions it is obvious that the acid treatment has a definite function. It dissolves a major portion of the mineral matter serving as lakes for the dyes, gums, and other impurities of the fiber. Consequently the impurities are rendered washable and the dyes are left exposed favorably to the attack of the bleaching agent.

Ammonium carbonate may be left out when the fiber is digested under atmospheric pressure. Results (Tables 6 and 10) reveal that a sample digested with a solution containing ammonium carbonate does not differ in yield and bleach requirement from another sample cooked without carbonate. It is obvious that the compound has no effect in the degumming of ramie under ordinary pressure, hence it may be omitted.

Pretreating (soaking) the raw material with cold water for 22 hours does not in any manner help in the removal of the gum, as Tables 7, 8, and 9 indicate. Approximately 5 per cent of the weight of the fiber was lost in the cold-water digestion. Any effect this pretreatment may have appeared to be negative, judging from the large amount of bleaching solution required to give the product a desirable degree of whiteness. That the impurities of ramie fiber are insoluble in water is to be expected, since the major portion of these impurities constitute gummy substances which do not dissolve in water.

Softening.—It was experienced that although the fiber is well purified, as in the case of samples 27 and 28 (Table 10), on drying the fiber becomes hard and stiff, due, possibly, to the residual gum which is resistant to the action of the cooking and bleaching liquors. Under these conditions, the fiber is not fitted for spinning.

To render the fiber soft without inflicting injury to it, is highly important. This is made possible by treating the purified fiber

from one to two hours with an emulsion of soap solution and kerosene.

The reaction of the emulsion toward the residual gum seems to be complex in nature. It is probable that the kerosene in the emulsion acts as a solvent for the gum. When the soluble gum is removed by washing, the treated fiber after drying is very soft and silky.

SUMMARY

1. From all indications ramie should be a profitable industry for the Philippines. There are now several plantations in Mindanao producing approximately 20,000 piculs of ramie ribbon annually.

2. Ramie fiber properly degummed is lustrous and looks almost like silk. The purified filasse could probably be industrialized into a profitable Philippine textile industry.

3. The degumming process developed in this work is considered effective and economical. Digestion of the fiber under pressure is not necessary. The time needed for purification is short.

4. The purified fiber has a high alpha cellulose content, showing that the process has little hydrolytic effect on the fiber during cooking.

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BOOKS

Books reviewed here have been selected from books received by the Philippine Journal of Science from time to time and acknowledged in this section.

REVIEWS

Synthetic Resins and Allied Plastics. By R. S. Morrell in Collaboration with T. Hedley Barry, R. P. L. Britton and H. M. Langton. London, Oxford University Press, 1937. 417 pp., illus. Price, \$11.

This book gives an excellent account of synthetic resins and of their preparation and properties. It contains many excellent suggestions for laboratory and factory practice. Good descriptions are given, with illustrations, of the machinery used in making commercial products from synthetic resins and thermoplastic materials.

Some of the more important subjects discussed are the following: molding resins of the bakelite and urea types; molding resins and plastics derived from casein and cellulose; manufacture and technique employed in molding; vinyl, styrene, acrolein, acrylic acid, coumarone, indene, and glyptal resins; resins in varnish and enamel manufacture; identification and testing synthetic resins.

Written in a clear and concise manner and giving a great deal of technique information along this line, this book is an excellent text and reference on synthetic resins.—A. P. W.

Teachable Moments. A New Approach to Health. By Jay B. Nash. New York, A. S. Barnes and Company, 1938. 244 pp. Price, \$1.50.

The author brings out an interesting and novel way of making a person health conscious. While many sound and accepted principles of health practices are incorporated in the book, there are personal idiosyncracies quite contrary to present teaching and scientific precepts.

In the chapter on "Truth and Part-Truths" the author seems to have seen more of the bad than of the good sides of many practices adopted in our public schools. If he had worked as a health officer in the schools, his field of vision would have been broader.—I. F.

Nature Study Above and Below the Surface. A Bridge Between Amateur and Professional. By H. C. Gunton. With a Preface by Dr. C. B. Williams. London, H. F. & G. Witherby, Ltd., 1938. 134 pp., illus. Price, 7s/6d.

The aim of the author in presenting this book is to stimulate the interest of those who wish to obtain more than mere superficial knowledge of some of the phenomena of natural life, which are at present engaging the attention of many workers, both professional and amateur. The book embodies the author's long years of experience as a keen amateur naturalist. The author is the present Director of the Phenological Report of the Royal Meteorological Society in Great Britain, a body composed of amateurs and professionals.

The aspects of natural life under ecology and phenology and other topics are dealt with in the introduction. Outstanding phenomena in nature, like natural protection, protective resemblance to surroundings, mimicry, variation, migration, and other phases of life are discussed in the second chapter. Notable examples of the work of professional entomologists in the control of noxious insects and plants are included in a chapter on applied entomology. In the last chapter the author makes several conclusions and recommendations.—S. R. C.

Soilless Growth of Plants. Use of Nutrient Solutions, Water, Sand, Cinder, Etc. By Carleton Ellis and Miller W. Swaney. New York, Reinhold publishing corporation, 1938. 155 pp., front., illus. Price, \$2.75.

This book gives a detailed description of the three recognized modifications of soilless growth, namely, water culture, sand culture, and subirrigation system.

Numerous household experiments and large-scale soilless-growth operations are discussed, and supplemented by drawings and photographs. The discussions and even the preparation of nutrient formulas are given in a popular style which can easily be understood by the layman. The authors are optimistic about the future of soilless-growth technique in plant cultivation.

—H. S. S.

The Vegetable Growing Business. By Ralph L. Watts and Gilbert Searle Watts. New York, Orange Judd Publishing Company, Inc., 1939. 549 pp., front., illus. Price, \$3.50.

The unique rôle now occupied by vegetables in the diet of the people has made vegetable growing one of the most important branches of modern agriculture. Among the most recent addi-

tions to vegetable literature the book entitled "The Vegetable Growing Business," by Ralph L. Watts and Gilbert S. Watts, commands attention. The senior author is a renowned professor and an authority on vegetable growing, while the junior author is a successful commercial vegetable grower. In this volume therefore, are combined the technical knowledge of a professor and the practical experiences of a grower.

The book is divided into 25 chapters and a list of references at the end. It is profusely illustrated. The first 12 chapters are devoted to a discussion of the general outlook of the industry, locations and soils, seeds, management, fertilizers, planting and cultivation, pests and diseases and their control, harvesting, storage, and marketing. The rest of the book is a detailed discussion of the cultures of the different groups of vegetables.

This book should be a good reference to both teachers and students of vegetable growing as well as to those actually engaged in or contemplating to engage in commercial growing of vegetables, particularly vegetables adapted to a temperate climate.—P. A. R.

Sheet Metal Work. By William Neubecker. Chicago, American Technical Society, 1938. 360 pp., illus. Price, \$2.50.

This is a work-type description of sheet metal work that is used in modern buildings and in manufacturing processes. The first part of the book and a few subsequent portions thereafter are devoted to principles the understanding of which requires a knowledge of geometrical principles: areas, surfaces, and the progressive development of complex surfaces. The development of patterns, like joints of cylindrical, conical, and spherical surfaces, are described. Joints of hexagonal and square forms are also explained.

Definite problems of actual construction, as the construction of cornices, skylights, roofs, flumes, and tube elbows, are taken up. The process used in the making of moulds for terra cotta or cement mouldings is described in detail. In order to help the sheet metal worker and designer, complete tables of sheet metal properties are given. These are distributed throughout the book and placed close to each subject matter which each supplements.

With the rapid progress of manufacturing industries, pressed metal manufacturing, building construction, air conditioning, and other trades requiring the use of sheet metal, the book is indispensable as a text and guide.—G. J. S.

Methods of Tissue Culture. By Raymond C. Parker. With a Foreword by Alexis Carrel. New York, Paul B. Hoeber, Inc., 1938. 292 pp., front., illus. Price, \$5.

Although the author in his preface makes it clear that the book is intended for both those who are not acquainted with the more recent developments in tissue culture and others who have never handled this work, an effort is made to orientate the reader in the extensive literature regarding various technics followed by leading researchers on the subject. Chapter XVI, for example, contains examples of the way in which the methods have been used in five important fields of investigation; namely, experimental morphology, the study of tumors and viruses, and hypersensitivity and immunity. The book includes a bibliography of supplementary references to experiments on this and other investigations not taken up in the text.

In a lengthy foreword the celebrated surgeon of the Rockefeller Institute, Dr. Alexis Carrel, who, years ago, took up seriously the work of tissue culture begun by Harrison in 1907, summarizes the importance of tissue culture in biology, to wit: "For the first time in the course of their history, biological techniques are capable of separating the living body into minute parts without destroying the life of those parts." In the beginning of the foreword he states thus, "Along with the inoculation of the dissection of the living or dead bodies and that of the microscopical examination of organs, the creation of the method of tissue culture is the most important event in the history of anatomy." In other words, tissue culture technics have made possible the study of living tissue cells and organs detached from the living body.

The author gives a brief history of tissue culture. Without the necessity of discussing the text chapter by chapter, the entire work represents, in abridged form, all the essential elements of successful methods of tissue culture. The subject as presented can easily be understood by a technical neophyte equipped with certain laboratory training and guidance. The presentation of the various types of cultivation in vitro of the different tissues of the body is sufficiently clear to make it workable. The application of these methods in the culture and maintenance of virus organisms of smallpox, fowl pox, encephalomyelitis, and infectious bronchitis is a reality, and vaccines have already been manufactured from such cultures with gratifying results. Tissue culture work bids for other important fields of study, such as

physiology, anatomy, medicine, surgery, biology, bacteriology, virology, and immunology.

Having been a student and associate of Doctor Carrel for many years, Doctor Parker, in his book, "Methods of Tissue Culture," has assembled in a concise manner most of the general practices in Doctor Carrel's laboratory, and has placed others within the reach of those who are interested in this fascinating subject. The most recent advances in tissue culture technic and the new fields of application have been carefully added.

The reviewer, even with his limited experience in this line of work, can attest to the thoroughness of the Carrel technic. At the Kaiser Wilhelm Institute für Biologie he used with success practically the same methods and procedures presented in this book. A culture of a tumor has been kept growing in that institution for the past 30 years. The study of the physiology, anatomy, growth, and the causative factor of tumors has taken a grip on the world scientists of today, and the method of tissue culture is being applied in tumor investigations with greater intensity than ever before.

The histology and micro-photography of growing tissues in culture, are very essential in the various applications of tissue culture not only from the standpoint of recording results, but also in interpreting intra- and extracellular changes in the growing process in the normal and abnormal state. These points are well taken up in the book in accordance with the more recent methods.

A most recent and valuable addition to the technic which may revolutionize anatomical or organic studies is that presented by Col. Charles A. Lindbergh in the culture of whole organs. Were this practicable, the progress of the disease processes in a given organ could then be ascertained with precision and thus solve the intricacies of morbidity. This new phase of the technic will no doubt receive careful study and verification by many workers.

Of great interest is the carefully prepared list of sources or references on the various fields of application. Within the limits of a book of less than 300 pages all the detailed sources can hardly be accommodated. Doctor Parker also gives comprehensive data on the subject of growth measurement, which is only lightly treated in other references of this nature.

The culture of adult tissue has been rather a difficult feat in many instances, but the book contains some enlightening directions to accomplish this successfully. The effects of X-ray, sen-

sitiveness to their biological factors, tissue allergy, and immunity *in vitro* are carefully treated. The text ends with a selected list of references pertinently arranged.—T. T.

Financing Agriculture. By L. J. Norton. Danville, Illinois, The Interstate, 1938. 326 pp., illus. Price, \$2.75.

This book is easily understandable by students and researchers in farm management, agricultural economics, and banking. It is intended as a textbook or reference for students in farm finance. It is an excellent guide for bankers and those who plan to set up efficient credit systems for financing agricultural activities, such as storing and distribution of farm products and financing coöperative associations. The book may also be of interest to legislators in formulating national policies relative to financing agriculture, rehabilitating the financial condition of the farmer during financial and business depressions, and aiding the low-income tenant farmer to acquire a farm. It is a good manual on the business aspects of farming, for it provides individual farming financing programs, and contains explanations on the wise use of credits, when to borrow and to pay loans, and when to keep and to sell farm products most profitably. The book suggests to lenders and borrowers a sound repayment program.

The author discusses the disadvantages of using capital borrowed from merchants, individuals, and private credit institutions. He gives a description of the United States Farm Credit Administration with a capital of nearly \$610,000,000 as an efficient system of financing American agriculture, which other countries, especially the Philippine Commonwealth, may adopt for financing agriculture.

The author has presented a more or less complete treatise on financing American agriculture; it could have been better, however, if the economic root of the agricultural problems or the evolution of financing American farmer from the beginning to the Farm Credit Administration had been included and treated in one chapter, so that the student, scholar, legislator, financier, and others could trace the historical background of the different stages in aiding the farmers of the United States. A chart showing the sources and means of credit open directly or indirectly to the producers of agricultural products would also be very helpful, especially to students and researchers in agricultural economics. The author concludes his book with an index.

—R. M. P.

Mental Health Through Education. By W. Carson Ryan. New York, The Commonwealth Fund, 1938. 315 pp. Price, \$1.50.

This book presents a detailed critical analysis of the widespread failure of classroom teachers to guide the emotions and mental attitudes of children. The criticisms, however, are directed mainly at the teacher-training schools which do not provide instruction on mental health. The author spares none in his attack, not even the most venerable and renowned of universities, colleges, and normal schools. He pleads for a reëxamination of teacher-training courses and methods, and advocates the Freudian philosophy and principles. He believes that psychoanalysis and modern psychiatry offer much saner help in school problems and problems of personality than the traditional psychologies.

Among the current educational practices which the author believes interfere with efforts to individualize education and to meet the needs of the children are grades and promotions, recitations and home work, examinations and marks, and discipline. In place of these he recommends projects, and accumulation for every individual youngster of all possible information regarding his life for the purpose of determining how best to help him.

It is in the administrative machinery, the author points out, that some of the most serious dangers to mental health in the schools lie. Highly organized systems are a threat to all efforts to make the individual child and his needs and possibilities the basic concern in education. To carry out its mass of activities from petty correspondence matters to major problems of finance, the administrative machinery overlooks those that concern human beings whether they be teachers, employees, or pupils.

Although the author is severe in his criticisms, he devotes more than half of his book to constructive procedures being done along mental health lines. He describes in some detail several movements for better education of teachers in which major emphasis is given to mental hygiene and personality development. Among the services which he should like to have a regular part of schools are: the visiting teacher, the child-guidance clinic, the school psychiatrist, the school psychologist, and the remedial or adjustment teacher.

The later part of this book is devoted to discussions on the limitations of mental health progress because of family, social, economic, government, religious, and cultural conditions. The book ends with a plea for a radical revision of educational philo-

sophy and methods for the sake of good mental health for children. To that end, the author believes, teacher-preparation schools, the curriculum, and educational administration will have to be enriched and humanized.—M. E.

Twenty-five Years of Health Progress. A Study of the Mortality Experience Among the Industrial Policyholders of the Metropolitan Life Insurance Company 1911 to 1935. By Louis I. Dublin and Alfred J. Lotka. With the Collaboration of the Staff of the Statistical Bureau. New York, Metropolitan Life Insurance Company, 1937. 611 pp., maps, illus.

The authors present a statistical study of mortality among industrial policyholders of the Metropolitan Life Insurance Company during the quarter century from 1911 to 1935 inclusive, embracing a large and representative sample of insured persons in the United States and Canada. This report shows the extraordinary progress in both the public health and the life insurance business. As one reviews the notable advances made in these 25 years, he is impressed by the increase in the average duration of human life in the group studied. Life duration was extended by nearly 14 years, or approximately 30 per cent of the average span following the development of a planned and concerted program of public-health activity among the insured.

In modifying the attitudes and habits of these millions whose coöperation had to be secured in order to put into practice the medical, public-health, and sociological gains of the past few decades, the company joined its forces with those of public and private health agencies. Joint efforts were exerted to raise health department standards throughout the country, to secure more adequate funds for health purposes, and to arouse public support and interest in new and promising methods of disease prevention and treatment. Thus the past 25 years have witnessed a great change in the health, habits of life, and environment of the American people.

The weekly premium-paying industrial policyholders rose from 8 million in 1911 to 17 million in 1935. The policyholders studied in this report are working people, mostly urban dwellers, in a variety of occupations which impose to a certain extent considerable wear and tear upon their health. It is a matter of common experience that urban mortality runs somewhat higher than rural mortality.

The most striking feature of the health picture has been the rapid decline in tuberculosis mortality. In 1911 tuberculosis

was the leading cause of death in the group studied, but in 1935 it ranked seventh in the list based on deaths at all ages combined. For ages from 1 year to 74 years it occupied the fifth place. The death rate from tuberculosis per 100,000 declined from 242 in 1911 to 56 in 1935 as a result of an active organized campaign against this disease.

The general decline of mortality from each disease mentioned herein is explained by the rapid development of medical science, the improved standard of living, and the better sanitary conditions under which men and women work. All in all, environmental factors, medical progress, and health activities have played an important rôle in producing the favorable health picture of the great masses of wage-earners that was enjoyed only by the well-to-do 25 years ago.

The extensive data accumulated during this quarter century undoubtedly shed much light on the health and welfare of the people. Consequently this volume is a useful source of information for health officers, physicians, sociologists, life insurance officials, and others interested in the development of medical science for advancing the cause of public health. The numerous charts and tables further enhance the value of this book.

—M. Ma. A.

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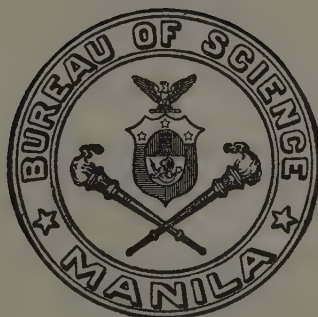


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